A MANUAL OF PRACTICAL ANATOMY

A MANUAL OF PRACTICAL ANATOMY

A Guide to the Dissection of the Human Body

BY

THOMAS WALMSLEY M D

In Three Parts.

PART I The Upper and Lower Limbs.
Second Edition.
With 117 Figures and 7 Plates.

PART II. The Thorax and Abdomen.
Second Edition.
With 82 Figures

PART III. The Head and Neck.
Second Edition
With 134 Figures and 3 Plates.

A MANUAL OF

PRACTICAL ANATOMY

A GUIDE TO THE DISSECTION OF THE HUMAN BODY

BY

THOMAS WALMSLEY

PROFESSOR OF ANATOMY THE QUEEN'S UNIVERSITY OF BELFAST

NEW EDITION

IN THREE PARTS

PART III—THE HEAD AND NECK

WITH 184 FIGURES AND 3 PLATES

LONGMANS GREEN AND CO
LONDON NEW YORK TORONTO

LONGMANS GREEN AND CO LTD
6 & 7 CLIFFORD STREET LONDON W 1

LONGMANS GREEN AND CO INC.
55 FIFTH AVENUE, NEW YORK 3

LONGMANS, GREEN AND CO
215 VICTORIA STREET TORONTO 1

ALSO AT MELBOURNE AND CAPE TOWN

ORIENT LONGMANS LTD
BOMBAY CALCUTTA, MADRAS

First Edition	*September 1932*
New Impression	*December 1933*
New Edition	*October 1938*
New Impression	*January 1941*
New Impression	*January 1944*
New Impression	*August 1945*

Printed in Great Britain by The Darien Press Ltd *Edinburgh*

PREFACE TO THE NEW EDITION

This manual remains, as in the first edition, primarily a directory of dissection of the human body for students in Medicine. It contains, therefore, only such explanations and descriptions as are necessary to guide the student in his work in the dissecting room and, it is hoped, as will indicate to him the form of knowledge he should aim at acquiring and the standard that may be expected of him. It is not intended to replace the systematic text-book of Anatomy, but rather to serve as an introduction to it. The text-book should be used as a book of reference for a fuller description of the parts of the body as they are met in the dissecting room and for the methodical study of the body systems and of those matters which cannot be investigated by dissection, and the more realistic figures in it, as aids in revision away from the body, will assist the student to visualise the structures and their relationships as they were seen in his own dissection.

The scope of this edition has been increased by introducing fuller descriptions of the examination of the living body and stressing the facts which are important in clinical practice. This is an attempt to meet some of the criticism of the teaching of Anatomy to medical students.

The introductory paragraphs on the general anatomy of the Head and Neck have been enlarged. It has been found to be an

advantage to the student to have this general conspectus before he begins the dissection.

The nomenclature which is used is that adopted by the Anatomical Society of Great Britain and Ireland.

I have once again to express my thanks to Miss M. R. Rea, B.A., for her assistance in the work of preparation, for the new diagrams, and for her care in reading the proofs.

CONTENTS

PLATES

A Manual of Practical Anatomy

VOL. III

THE HEAD AND NECK

INTRODUCTION

The dissection of the head and neck is very largely a dissection of the nervous system for it includes the examination of the brain and spinal cord and the membranes (meninges) in which they are enclosed the organs of special sense and the cranial and spinal nerves. The brain is contained in the cavity of the skull and the organs of special sense in cavities bounded by or within the bones of the skull and the spinal cord is contained in the upper half or a little more of the vertebral canal of the vertebral column. The study of these bones, therefore namely the **skull as a whole** and the **vertebral column**, is necessary before the dissection is begun and further a skeleton of the skull should be beside the dissector during the dissection and constant reference made to it. The dissector is also to make himself thoroughly familiar with the following diagrams and X ray photographs of the skull and the neck and the explanatory figures that accompany them a knowledge of them is the introduction to the dissection.

The **general form of the skull** and the principal characters and proportions of it parts are hereditarily determined the major subdivisions of mankind having recognisable peculiarities of general and special form the facial parts are more variable than the cranial parts. The two chief forms of the cranial part of the skull among Europeans are when they are purely expressed the **dolichocephalic** or long headed skull and the **brachycephalic** or round headed skull (Fig 3) and when the whole skull is harmonic the facial parts correspond with them in the one type the face is long and narrow and in the other it is short and broad. The two types correspond and are usually associated with the two types of general body form, in one of which growth is emphasised in the length axes of the parts of the body and in the other it is emphasised in the transverse axes (see Vol. II) but in many individuals

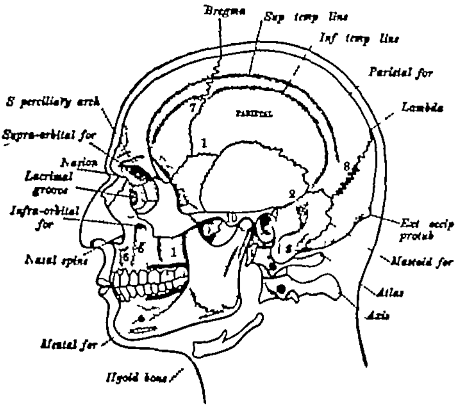
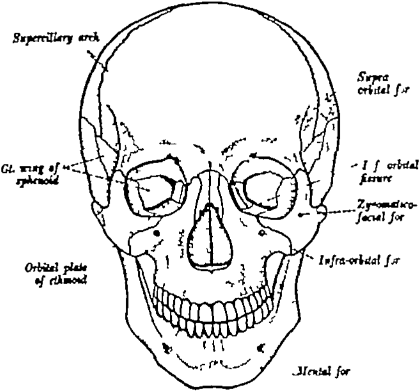


FIG. 1

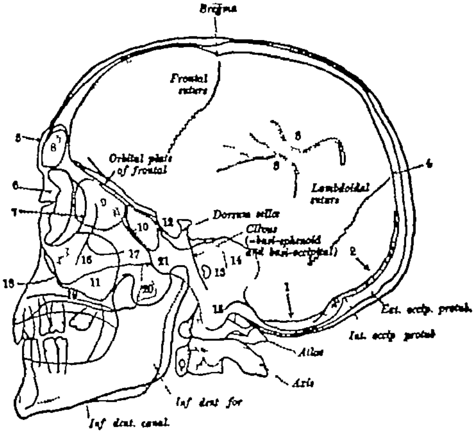
The head and neck from the side with the bones in position. The skull and face bones are to be identified, coloured, and named; namely the frontal, parietal, occipital, temporal, great wing of sphenoid, zygomatic maxilla, nasal, lacrimal, orbital plate of ethmoid, and mandible

1, Pterion; 2, supra mastoid crest 3, mastoid process; 4 styloid process; 5, canine fossa; 6, incisor fossa 7 frontal suture 8, lambdoid suture; 9, lateral pterygoid plate; and 10, tubercle at root of zygomatic arch.



FIG

The skull viewed from the front. The individual bones are to be identified, coloured, and named namely the frontal, parietal, great wing of sphenoid, squamous temporal, zygomatic, nasal, maxilla, and mandible and, forming the walls of the orbit the frontal, zygomatic maxilla, lacrimal, orbital plate *of ethmoid*, and *great wing of sphenoid. The nasal septum separates the* two nasal cavities.



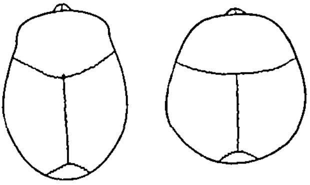
KEY TO PLATE I.

1, Cerebellar fossa; 2, occipital fossa; 3, diploic venous channels; 4, lambda; 5, superciliary arch; 6, nasal bone; 7, lateral margin of orbit; 8, frontal sinus; 9, ethmoidal air cells; 10, sphenoidal sinus; 11, maxillary sinus; 12, sella turcica; 13, external auditory meatus; 14, petrous temporal bone; 15, mastoid process, in which are the mastoid air cells; 16, zygomatic bone; 17, zygomatic arch; 18, nasal spine; 19, hard palate; 20, lateral pterygoid plate behind posterior border of maxilla; 21, tubercle at root of zygomatic arch.

PLATE I

there is a disharmony of the parts of the skull and of the body due it is supposed to a mixed inheritance

The **length of the cranium** (L) is measured with calipers from the nasion (the mid point of the fronto-nasal suture) to the most backwardly projecting point in the occipital region. The **breadth of the cranium** (B) is the greatest transverse diameter measured with calipers wherever it may be it is usually above the ears in the hinder parietal region. The **cephalic index** is the proportion of the breadth to the length of the skull and is obtained by the formula $\frac{B}{L}\times 100$ if the index is 75 or less the skull is dolichocephalic in type and if it is 80 or more it is brachycephalic A large number of European skulls have indices between 75 and 80 they are known as mesocephalic skulls, but though they are intermediate rather than pronounced in general form they



( ) (b)

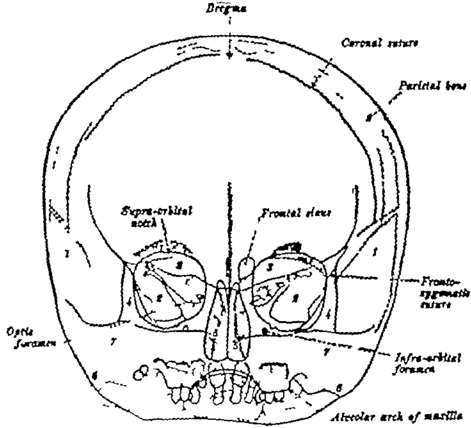
Fig 2.

The outlines from above of ( ) a typical dolichocephalic skull, and (b) a typical brachycephalic skull.

usually conform in their details more to one than the other of the pure types. The **height of the cranium** (H) is the length of the line from the highest point of the skull (usually near the bregma) to the line which joins the external auditory meatuses in round skulls it is usually greater than in long skulls. The three dimensions—length breadth and height—having been obtained it is possible to calculate the **capacity of the cranium** and so to estimate the volume of the brain.

The skull is normally slightly asymmetrical both in its cranial and facial parts, the asymmetry often being pronounced and easily seen in the occipital region and in the upper and lower jaws.

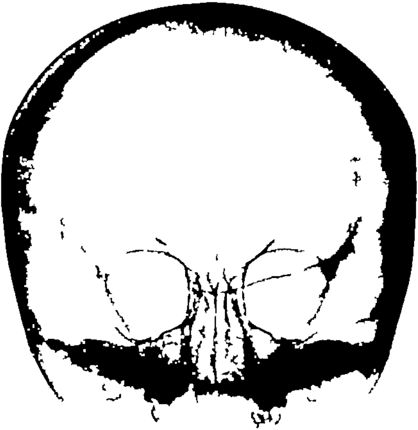
The bones of the skull, with the exception of the mandible are in the adult immovably united and form a firm base on which the mandible moves and with which it comes into forcible contact when the teeth are occluded in chewing and in order better to withstand the stresses



KEY TO PLATE II.

1, Squamous temporal bone; 2, great wing of sphenoid; 3, lesser wing of sphenoid; 4, [illegible] bone; 5, nasal cavity with conchæ; 6, mastoid process; 7, petrous temporal bone. The permanent teeth (unerupted) are shaded; the deciduous teeth (erupted) are unshaded, and the arch of the palate lies above them. The base of the skull is invisible, but on it the occipital foramen and the occipital condyles can be recognised.

PLATE II



of occlusion it is strengthened in those parts which receive and transmit them for example, the zygomatic bone and its frontal and zygomatic processes the frontal process of the maxilla and the lateral and medial angular processes and the superciliary arch of the frontal bone. The chief muscles of the head are therefore the muscles of mastication, most of which arise from the skull and are inserted on the mandible. The skull however can be freely moved as a whole on the upper end of the vertebral column the upper cervical region of which (C 1 to 4) moves with it and greatly increases its range. The chief movements are flexion forwards and extension backward lateral flexion (bending to the sides) horizontal rotation round a vertical axis and combinations of the three groups of movements and they are produced by the muscles of the neck, which form so large a part of the substance of the neck (Fig 4) and by the weight of the head

The muscles of the head are arranged in the following groups —

1 The **Ocular Muscles.**—A group of six muscles which lie in the orbit and are attached to the surface of the eyeball they maintain it in a position of equipoise by their tonic action and by their co-ordinated contraction they simultaneously direct the eyeballs towards the object looked at. A seventh orbital muscle is inserted into the upper eyelid and acts as an elevator of it.

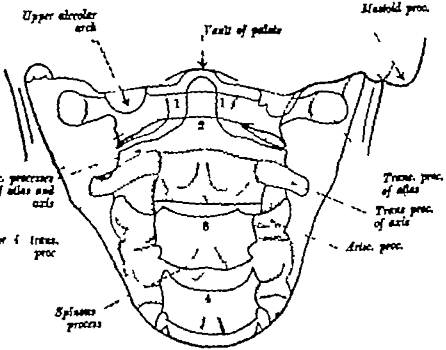
2. The **Muscles of Mastication.**—A group of muscles attached to the lower jaw and taking part in effecting the movements of chewing speaking and swallowing. The chief and largest members of the group are the elevators of the jaw which arise from the skull and are inserted on the mandible but there are also two muscles of mastication in the floor of the mouth and one member of the group is inserted into the soft palate.

3. The **Muscles of Expression.**—A system of muscles which lie immediately below the skin in the scalp the face and the anterior surface of the neck. They are attached at one end to bone or fascia and at the other end to the skin and by their contraction they produce movements of the skin. They are sometimes named the cutaneous muscles of the head and those on the face are often termed the facial muscles.

4 The **Muscles of the Tongue.**—The tongue is essentially composed of muscle fibres which together form a group of intrinsic muscles of the tongue There is also a group of extrinsic muscles which arise from the neighbouring bones—for example the styloid process and the hyoid bone—and are inserted into the tongue

The muscles of the neck form the main part of the substance of the neck. They are attached below to the sternum, the first and second ribs, the clavicle and the scapula, and the upper thoracic and lower cervical vertebræ and running longitudinally in the neck are attached above to the upper cervical vertebræ and the skull They are arranged in the following groups (Fig 4) —

1 The **Rectus Muscles.**—These muscles lie on the front of the neck near the middle line. They are subdivided into two groups, namely



K[illegible] TO PLATE III.

1 Anterior arch of the atlas [illegible], base of odontoid process of the axis; 3 and 4, bodies of the third and fourth cervical [illegible]ert[illegible]bræ [illegible] Note the great width of the transverse processes of the [illegible]tlas, the separation of the bodies of the [illegible]ertebræ, and that the anterior surface of the arch of the atlas and of the bodies of the succeeding three vertebræ can be palpated through the mouth.

PLATE III

(a) those arising below from the sternum the first costal cartilage and the scapula and inserted above into the thyroid cartilage and hyoid bone the **infra-hyoid muscles** and (b) those extending from the hyoid bone to the mandible and forming with the muscles of the floor of the mouth the **supra hyoid muscles**. The muscles of the rectus group are innervated by the anterior primary rami of the cervical nerves.

2. The **Pre-vertebral Muscles**.—A group of muscles which lie on the front of the bodies of the cervical vertebræ extending from the upper thoracic region to the base of the skull. They are innervated by the anterior primary rami of the cervical nerves.

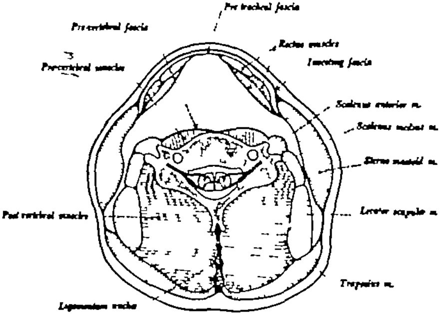


FIG. 4

The muscles of the neck as seen on transverse section.

3. The **Lateral Muscles**.—These muscles, lying on the side of the neck are disposed in two layers, namely a superficial layer (the sterno-mastoid and the trapezius) innervated by the accessory (eleventh cranial) nerve and a deep layer (the scalene muscles and the levator scapulæ) innervated by the anterior primary rami of the cervical nerves.

4. The **Post-vertebral** or **Dorsal Muscles**.—These muscles form a large mass on the back of the neck, filling the hollow at the side of the spinous processes and behind the laminæ and transverse processes of the vertebræ; they are the cervical parts of a similarly placed mass of muscles which extends from the sacrum below to the skull above. They are supplied by the posterior primary rami of the cervical nerves. In the neck these muscles are covered by the cervical part of the

trapezius, and behind the spinous processes the muscles of the two sides are separated by a broad dense fibrous septum, the **ligamentum nuchæ** (Fig. 4).

Each group of the neck muscles is enclosed in its own layer of fascia the several layers together forming a composite fascial system known as the **deep cervical fascia**. (1) *The most* **superficial layer** *of the fascia* is that which encloses the sterno-mastoid and trapezius muscles and invests the whole circumference of the neck. It is attached behind to the ligamentum nuchæ and after investing the trapezius passes from its anterior border to the posterior border of the sterno-mastoid between the muscles it forms the covering of an intermuscular interval, known as the **posterior triangle of the neck**, which is floored by the levator scapulæ and the posterior members of the scalene group. The layer invests the sterno-mastoid muscle and from its anterior border is continued round the front of the neck to the opposite side it passes superficial to the rectus muscles. (2) The rectus muscles of the two sides are enclosed in a layer known as the **pre-tracheal fascia**. It forms, with the rectus muscles, a triangular fibro-muscular sheet, much broader below than above, which lies in front and at the sides of the larynx and trachea and, *as is seen in transverse section (Fig. 4) the lateral* edges of the sheet fuse with the investing fascia on the deep surface of the sterno-mastoid muscle. (3) The pre-vertebral muscles are covered in front by the **pre-vertebral layer** of fascia. This is continued laterally beyond the pre-vertebral muscles, over the scalene and levator scapulæ muscles in the floor of the posterior triangle of the neck and ends behind by fusing with the deep fascia on the back of the neck.

The rectus the lateral and the pre-vert bral muscles of the neck and their investing fasciæ bound and enclose a space on the front of the neck (Fig 4) in the middle part of which lie the **cervical viscera**, namely the **pharynx and œsophagus**, the **larynx and trachea**, and the **thyroid gland** (Fig 6) At the sides of the viscera in the lateral extremities of the space lie the chief **blood vessels** and **nerves** of the neck, namely on each side the **internal jugular vein**, the **carotid system of arteries**, and the **last four cranial nerves** for at least parts of their course these structures are contained in a special sheath of deep fascia known as the **carotid sheath** (Fig 6) *The neuro-vascular spaces are continued backward behind the sterno-mastoid muscles into the posterior* triangles of the neck in which lie the **cervical** and **brachial plexuses** of nerves and their branches several backwardly directed arteries and veins and backward extensions of the chain of lymph glands which lies along the internal jugular vein

The general anatomy of the brain and spinal cord is described later; the general anatomy of the spinal nerves is described in Vol I

The **organs of special sense**, which are attached to the brain, are arranged symmetrically on the two sides of the head They are —

1 The **olfactory organ** serves the sense of smell It consists of an *olfactory receptor surface which is lodged in the mucous membrane of the uppermost part of the nasal cavity and is stimulated by the passage*

over it of the inspired air in which the substance to be smelt is suspended.

2. The **organ of sight** is the eyeball it lies in the orbit and is protected by its bony wall On the inner surface of the wall of the eyeball is a layer of nervous substance the retina which is the receptive layer of visual stimuli.

3. The **organ of hearing** is the cochlea of the internal ear It lies in the petrous part of the temporal bone and *leading to it is a series* of passages in which the sound waves of the air are converted into movements of a fluid by which the nerve endings in the cochlea are stimulated. The passages are the auricle popularly called the ear the external auditory meatus a tubular passage about an inch long leading inwards from the auricle and closed at its inner end by the tympanic membrane or drum of the ear and the middle ear or tympanic cavity an air-containing space in the petrous temporal bone in which there is a chain of minute bones the auditory ossicles (Fig 75)

4 The **vestibular organ**, the special organ of equilibration (the balancing of the body) is also a part of the internal ear disturbances of it produce sensations of unbalance or giddiness

5 The **organ of taste** is scattered in minute parts over the surface of the mouth chiefly on the tongue but also on the soft palate and the oral part of the pharynx.

The **cranial nerves**, of which there are twelve pairs are attached to the brain as the spinal nerves are attached to the spinal cord but they differ from the spinal nerves in that some of them are purely motor nerves, some of them purely sensory nerves and only some of them mixed motor and sensory nerves. The nerves are known both by their numbers in the series and by their names, and the following table gives also a summary of their distribution it is to be referred to as the student becomes familiar with the nerves.

1. **Olfactory nerve**: the nerve of smell. It consists of about twenty branches which originate in the olfactory mucous membrane in the upper part of the nasal cavity
2. **Optic nerve** the nerve of sight It originates in the retina of the eyeball and *transmit the visual stimuli received there to the brain.*
3. **Oculo-motor nerve**: the motor nerve to the ocular muscles (except the superior oblique and lateral rectus muscles). It also supplies some of the intrinsic (involuntary) muscles of the eyeball through the parasympathetic motor fibres it carries.
4. **Trochlear nerve** the motor nerve to the superior oblique ocular muscle.
5. **Trigeminal nerve**: the sensory nerve of the face, the front part of the scalp, the external parts of the eye, the nasal cavity the mouth, and the teeth. It is distributed to these *regions in three branches* or divisions, namely the first or **ophthalmic division**, the second or **maxillary division**, and the third or **mandibular division**. It is also the motor nerve to the muscles of mastication and the other muscles developed from the same muscle mass, namely the tensor tympani, the tensor palati, the mylo-hyoid, and the anterior belly of the digastric muscle the motor fibres are distributed through the third

or mandibular division of the nerve—the first and second divisions are purely sensory nerves.

6. **Abducent nerve**; the motor nerve to the lateral rectus ocular muscle.

7. **Facial nerve**: the motor nerve to the muscles of expression and the other muscles developed from the same muscle mass, namely the stapedius, the stylo-hyoid, and the posterior belly of the digastric muscle. It is also the secreto-motor nerve to the submandibular and sublingual salivary glands through the parasympathetic fibres in its chorda tympani branch. The facial nerve also contains sensory fibres, few in number compared with the motor fibres; they are distributed through its chorda tympani branch to the anterior two-thirds of the tongue—the nerve of taste.

8. **Auditory nerve**: the sensory nerve which transmits impulses from the internal ear. It consists of two sets of fibres; (1) those which compose the cochlear nerve, the nerve of hearing, originating in that part of the ear (the cochlea) in which the auditory stimuli are received, and (2) those which compose the vestibular nerve, originating in those parts of the ear (the vestibule and the semicircular canals) in which arise the stimuli that are concerned in the balancing of the body and the movements of its parts necessary to obviate the action of gravity.

9. **Glosso-pharyngeal nerve**: mixed nerve. It is the sensory nerve to the back of the tongue and the pharynx and the motor nerve to the stylo-pharyngeus muscle. It also supplies secreto-motor (parasympathetic) fibres to the parotid salivary gland.

10. **Vagus nerve**: mixed nerve. The motor fibres supply the (voluntary striped) muscles of the pharynx and the crico-thyroid muscle of the larynx, and the (involuntary unstriped) muscles and glands of the oesophagus, stomach, small intestine and beginning of large intestine, the trachea and bronchi, and the muscle (myocardium) of the heart. The sensory fibres are distributed to the same parts, namely the greater part of the alimentary system, the respiratory system, and the heart; a sensory branch is also given to the skin of the external auditory meatus.

11. **Accessory nerve**: motor nerve. It consists of two parts, namely (1) a cranial or bulbar part which joins the vagus nerve outside the skull and is distributed through its branches to supply the muscles of the soft palate (except the tensor palati and palato-glossus) and the muscles of the larynx (except the crico-thyroid); and (2) a spinal part which supplies the sterno-mastoid and trapezius muscles.

12. **Hypoglossal nerve**: motor nerve. It supplies the intrinsic and the extrinsic muscles of the tongue.

There are also in the head and neck, in addition to the parts of the nervous system, the first parts of the digestive and respiratory systems.

The **digestive system** begins in the mouth, where the food is received and, if necessary, comminuted by mastication before it is swallowed. The **mouth** is bounded in front and at the sides by the **lips and cheeks**, above by the **palate**, which separates it from the nasal cavities, and below by a **muscular floor** which stretches between the two sides of the body of the lower jaw and extends backwards as far as the hyoid bone (Fig. 5). The **alveolar arches** of the upper and lower jaws

covered with the gum and carrying the teeth project into the mouth and divide it into two parts namely a part superficial to them between them and the lips and cheek the **vestibule of the mouth**, and a part within them the **mouth proper** The **tongue** lies

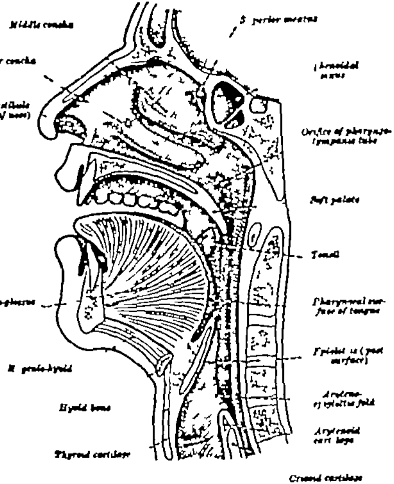


FIG 5.

A diagram of median longitudinal section through the nose mouth, pharynx, and larynx. The vertebræ are to be numbered. The bones of the base of the skull, the hard palate, the lower jaw the hyoid bone the cartilages of the larynx, and the muscles of the floor of the mouth are to be coloured; and lines are to be drawn to show the course of the food and the respired air

in the mouth proper and almost fills it when it is closed it is attached by its root to the floor of the mouth and the hyoid bone The **salivary glands**, which lie in the walls of the mouth pour their secretion, the **saliva** into the mouth by their ducts the saliva moistens the food while it is being chewed. The food receiving and masticatory apparatus

thus includes (1) the mouth and the parts accessory to it namely the teeth the tongue and the salivary glands (2) the muscles of mastication and the temporo-mandibular joint at which they act and (3) the parts of the face and skull, the masticatory face, which carry the teeth and meet and bear the stresses of mastication. This apparatus is of special importance to the dental student.

The mouth opens behind, and by the act of swallowing the food passes from it into the **pharynx**, a muscular walled cavity lined with mucous membrane which lies in front of the pre-vertebral muscles and fascia and the upper six cervical vertebræ (Fig. 5) the muscles of the pharyngeal wall are striped muscles and in the mucous membrane there is much lymphoid tissue. The **oro-pharyngeal orifice**, that is, the opening from the mouth into the pharynx, is the narrow passage bounded at the sides by the **palato-glossal arches**, shelf-like folds of mucous membrane which extend from the palate to the tongue and contain within them the palato-glossal muscles. The student is to examine these arches in his own mouth they lie immediately in front of the **tonsils**, masses of lymphoid tissue in the lateral walls of the pharynx. At its lower end, opposite the sixth cervical vertebra, the pharynx is continued into the **œsophagus** or gullet, a muscular walled tube lined with mucous membrane which passes downwards in front of the vertebral column through the lower part of the neck and the thorax into the abdomen and carries the swallowed food to the stomach. The muscles of the œsophageal wall are mainly involuntary unstriped muscles.

The **respiratory system** begins with the **nasal cavities**, the two chambers of the nose, which are separated from one another by a median partition, the nasal septum. They are lined by a thick, highly vascular mucous membrane, the extent of which i increased by its folding over the **conchæ**, three delicate bones on their lateral walls in passing over the mucous membrane the inspired air is warmed and moistened. The nasal cavities open to the exterior in front by the **nostrils**. They open behind above the palate into the upper or nasal part of the pharynx which extends upwards behind them as far as the base of the skull (the basi-sphenoid and basi-occipital bones) which forms its roof and part of its posterior wall (Fig 5) The inspired air passes downwards in the pharynx and from it into the **larynx**, a cartilage-walled cavity lined with mucou membrane, the inlet of which opens on the anterior wall of the pharynx below the back of the tongue In the larynx there are the **vocal folds**. The **laryngeal cartilages** are (1) the **epiglottis**, which lies t the back of the tongue (2) the **thyroid cartilage**, which lies in the anterio and lateral walls of the larynx and can be felt on the front of the neck below the hyoid bone (Adam's apple of the male) (3) the **cricoid cartilage**, a signet ring shaped cartilage which lies below the thyroid cartilage, its broad part being behind and (4) the two **arytenoid cartilages**, which surmount the posterior part of the cricoid cartilage (Fig 97) At the lower border of the cricoid cartilage which lies opposite the sixth cervical vertebræ the larynx is continued into the **trachea** or windpipe. It is a tubular

structure in whose wall there are rings of cartilage to keep it permanently patent It passes downwards through the lower part of the neck into the thorax in front of the oesophagus and conveys the inspired air into the bronchi for distribution to the lungs.

The pharynx and the oesophagus and the larynx and the trachea occupy the middle part of the space on the front of the neck that as was described (p. 10) is bounded by the rectus, lateral and prevertebral groups of muscles and the fasciæ related to them (Fig 4) and in this space the respiratory organs are immediately in front of the digestive organs (Fig 6) There is also in this space the thyroid

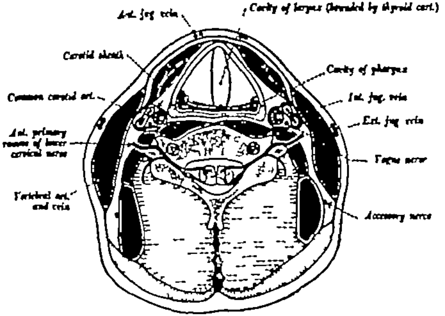


FIG 6.

A diagram of a transverse section of the neck with the cervical viscera and the main blood vessels and nerves of the neck in position. The student has to name the main groups of muscles and the layers of the deep cervical fascia.

gland, a large ductless gland, pathological enlargement of which (goitre) is not uncommon It lies at the sides of the lower part of the larynx and the upper part of the trachea the two lateral parts being connected by a narrow transverse part the isthmus across the front of the trachea (Fig. 52)

The **arteries of the head and neck** are almost entirely derived from the carotid system. This system begins as the **common carotid artery** which on the right side is a branch of the innominate artery and on the left side a direct branch of the arch of the aorta (Fig 7) It passes upwards into the neck from the thorax behind the sterno-clavicular joint and ascends on the lateral side of the cervical viscera resting

behind on the pre-vertebral fascia in the interval between the pre-vertebral and scalene muscles (Fig. 6) It itself does not as a rule give

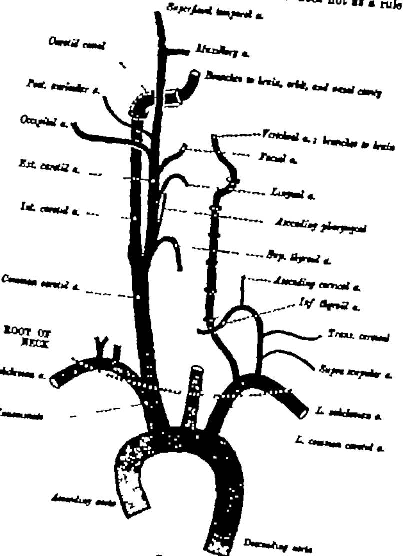


FIG 7

A diagram of the arteries of the head and neck The student is to commence at the arch of the aorta and study the main arteries and learn their branches of distribution.

off any branches but at the level of the upper border of the thyroid cartilage it divides into the internal and external carotid arteries from

which the branches of distribution of the carotid system arise Th internal carotid artery continues the course of the parent artery to the base of the skull and passing through the carotid canal in the petrous temporal bone enters the cranial cavity it is distributed there to the brain the structures in the orbit and the upper part of the nasal cavity The external carotid artery gives off a number (eight) of branches which are distributed to practically all parts of the head and neck, namely the bones of the skull and neck the muscles of the head

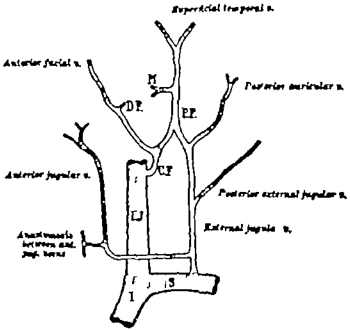


FIG. 8.

A diagram of the veins of the head and neck. The veins are to be coloured and their names are to be learnt.

I., innominate vein; S., subclavian vein; I.J internal jugular vein; C.F., common facial vein; P.F posterior facial vein; D.F deep facial vein; and M maxillary vein.

and neck, and the organs of the digestive and respiratory systems the dissector will therefore meet these branches in almost every part of the dissection.

The subclavian artery which crosses the root of the neck (Fig 7) gives off branches that supply the parts there, namely the bones, the muscles, and the viscera and it gives off also a large ascending branch the vertebral artery which ascends through the foramina of the transverse processes of the upper six cervical vertebræ (Fig 6) and passes through the foramen magnum into the cranial cavity to take part in the supply of the brain.

The **veins of the head and neck**, returning the blood from the brain, the bones, the muscles and the viscera with a few exceptions join the jugular system of veins the exceptions are the vertebral vein which joins the subclavian vein, and some veins from the root of the neck which join the innominate vein. Two jugular veins the anterior and external jugular veins, are superficial veins they lie in the superficial fascia and receive branches from superficial parts The anterior vein joins the external vein at the root of the neck and this vein almost immediately afterwards opens into the subclavian vein (Fig. 8) The third jugular vein the **internal jugular vein**, commences at the jugular foramen on the base of the skull where it receives the returning blood from the brain, the orbit, and the upper part of the nose. It passes downwards the whole length of the neck on the lateral side of the internal and common carotid arteries, and at the inlet of the thorax behind the sterno-clavicular joint, joins the subclavian vein to form the innominate vein (Fig. 8) In its course it receives branches from the superficial and deep parts of the head and neck. It is enveloped with its accompanying artery in a special sheath of the deep cervical fascia which is known as the **carotid sheath** (Fig. 6).

THE ORDER OF DISSECTION

The dissection of the parts of the nervous digestive and respiratory systems in the head and neck and the bones muscles and blood vessels there cannot be carried out in any systematic order rather in fact considered systematically the dissection is at first confusing for small parts of the systems, unordered in their sequence are met in most of the regions into which the head and neck is divided The student must therefore be clear in his mind what it is he is to dissect in each region before he begins its dissection and have a sufficient general knowledge of the bones the groups of muscles, the blood vessels, and the nervous, digestive and respiratory systems to be able to refer each part he meets to its place in the whole but this is difficult of the cranial nerves. The relations of the parts which are important in the head and neck are best remembered when the gross relations of the systems are known it is for their sake that the dissection is conducted in regions but the topographical or regional anatomy must be founded and built up on a knowledge of the systematic anatomy

The order of dissection recommended is as follows and in brackets is the number of days the student should allot to each region —

1 The body is placed in the lithotomy position. Dissection of the **superficial parts of the face**—including the **muscles of expression**, the **accessory parts of the eye**, the **external nose**, the **lips** and **cheeks**, and the **superficial nerves and blood vessels**—and the **anterior part of the scalp** (3)

2. The body is placed face downwards. Dissection of the **posterior part of the scalp**, the **external ear** the **superficial parts of the back of the neck** including the upper part of the **posterior triangle of the neck**, the **post vertebral muscles** of the back and neck, and the **sub-occipital triangle** (6)

3. The body is placed on its back. Dissection of the lower part of the **posterior triangle of the neck**, superficial dissection of the front of the neck including the **rectus muscles**, and deep dissection of the **root of the neck** including the **subclavian and common carotid arteries** (6)

4 Deep dissection of the **temporal** and **infra-temporal regions** of the head including the **parotid gland**, the **muscles of mastication**, and the **temporo-mandibular joint** (4)

5 Deep dissection of the **submandibular region** including the **floor of the mouth**, the **salivary glands**, and the **root of the tongue** (3)

6 Deep dissection of the **front and side of the neck** including the **main blood vessels and nerves**, the **scalene muscles**, and the **thyroid gland** (4)

7 Removal of the brain and spinal cord. Dissection of the **cranial and spinal dura mater** and the **cranial fossae** including the **cranial blood sinuses** (3)

8. Dissection of the orbit including the ocular muscles and the eyeball (3)
9. Dissection of the middle ear the internal ear and the facial nerve (2)
10. Dissection of the pre-vertebral region of the neck including the pre-vertebral muscles and the vertebral joints (2)
11. Dissection of the mouth, the pharynx, and the cervical part of the oesophagus (4)
12. Dissection of the larynx and the cervical part of the trachea (2)
13. Dissection of the nasal cavities including the air sinuses of the cranial and facial bones (3)
14. Dissection of the brain and spinal cord. (This dissection is best postponed to one of the vacations and some time, say three weeks given to it.)

SUPERFICIAL DISSECTION OF THE FACE AND THE ANTERIOR PART OF THE SCALP

The body is placed in the lithotomy position when it is brought into the dissecting room, and it remains in this position for three days. It is convenient during this time for the dissectors of the head and neck to dissect the superficial structures of the face and the anterior part of the scalp. More particularly the dissection comprises the examination of the following parts —

1. The bony landmarks of the face and forehead.
2. The facial muscles of expression.
3. The superficial accessory parts of the eye, namely the eyebrows, the eyelids, the conjunctiva, and the lacrimal apparatus.
4. The external nose.
5. The lips and the cheeks.
6. The superficial blood vessels and lymph vessels of the face and forehead.
7. The superficial nerves of the face and forehead, namely the terminal parts of (a) the facial (seventh) nerve, which is motor to the muscles of expression, and (b) the trigeminal (fifth) nerve which i the sensory nerve of the skin.

The student must have an articulated skull beside him throughout the dissection.

Surface Anatomy.—The student is first to examine the bony land marks of the face and f rehead on the articulated skull and by a free examination identify them on himself he is then to localise them on the subject and mark their position on the skin with a pencil, and t the same time to name them on Figs. 1 and 2.

The forehead is more perpendicular in the child and the female than in the male. On each half of the forehead the area of greatest

convexity is the **frontal eminence** it is conspicuous in children and remains more conspicuous in women than in men in whom as a rule it is hardly to be determined The sex differences of the forehead are due to the greater forward growth of its lower part in the male than in the female The **sagittal suture** between the parietal bones, or a slight ridge in its position, may not be palpable but the **coronal suture** or its position can usually be defined about an inch behind and parallel to it th re is often a broad groove on the skull which can be seen and felt The **parietal eminence** is the region of greatest convexity of the parietal bone it lies behind the post-coronal groove and at or above the greatest width of the skull and though it is more prominent in child hood and less evident in the adult it is usually easily located with the palm of the hand The **bregma** is the place of junction of the sagittal and coronal sutures frequently there is a slight depression of the skull at it.

The orbit is the cavity which contains the eyeball. Its opening on the face is almost square-shaped and lies slightly obliquely The **supra-orbital margin** of the frontal bone which is to be felt in its whole length, forms the upper boundary of the opening and the upper parts of its medial and lateral boundaries (Fig ?) The medial third of the margin is rounded and indistinct but its lateral two-thirds is sharp though less sharp in the male than the female at the junction of the two parts is the **supra-orbital notch**, the lateral edge of which is more prominent than the medial edge In the living subject it is more easily felt when palpated from below and the **supra-orbital vessels** and **nerve** that traverse the notch can be rolled on the bone above it in some skulls, however the notch is converted into a foramen which cannot be felt. The **eyebrow** is the thickened freely movable fold of skin that covers the supra-orbital margin. The short stiff hairs it carries are usually directed laterally they serve to lead the sweat of the brow away from the orbital opening In the young they are placed at a higher level than in the adult and along a more curved line, and cosmetic treatment seeks to restore or imitate the arrangement of infancy The curved ridge of bone above the medial part of the supra orbital margin is the **superciliary arch** it varies greatly in its size, being more prominent in men and little developed or even absent in women, and is more easily felt when the eyebrow is drawn down. Its medial part lies in front of the frontal air sinus, which does not, however extend into it The slightly elevated region of the frontal bone between the superciliary arches is the **glabella** the skin over it is usually devoid of visible hairs. The lateral end of the supra-orbital margin is the **zygomatic process of the frontal bone**, and there—close to the lateral end of the eyebrow hairs—the suture between the frontal and zygomatic bones may usually be felt through the skin often there is a small tubercle on the zygomatic bone immediately below it

The lower margin of the orbital opening is formed by the **zygomatic bone** and the **maxilla**, the former bone forming also the chief part of the lateral margin and the latter bone the chief part of the medial

margin (Fig 2) The whole **facial surface of the maxilla** is to be felt between the side of the nose and the prominence of the cheek, and on it the **infra-orbital foramen**, which transmits the **infra-orbital vessels and nerve**, is to be sought with the finger tip It lies about a quarter of an inch below the infra-orbital margin on a vertical line drawn downwards from the supra-orbital notch the line should pass between the premolar teeth of the lower jaw (Fig 2) Below the foramen is the **canine fossa** of the maxilla a distinct and palpable hollow bounded medially by the ridge caused by the socket of the canine tooth. There is a slight depression the **incisor fossa**, over the lateral incisor tooth it can be felt below the angle of the nose.

The **zygomatic bone** forms the bony prominence immediately below and lateral to the orbit and from it the **zygomatic arch** is easily followed backwards under the skin to the front of the auricle It is formed by the zygomatic bone and the zygomatic process of the temporal bone. The region above the zygomatic arch is the **temporal fossa**, and in it lies the **temporal muscle** the muscle can be felt to harden when the teeth are clenched. The fossa is bounded above by the upper temporal line. The two temporal lines, the upper and lower begin together on the posterior border of the zygomatic process of the frontal bone and arch upward and backwards on it as a palpable and often visible ridge that separates the forehead from the temple (Fig 1) The ridge then divides into the two temporal lines which become less distinct to palpation, but on the skull at least they are to be followed backwards below the parietal eminence. The upper line ends at the posterior border of the parietal bone, but the lower line crosses its lower edge and is to be traced in its curve downwards and forwards until it joins the **supra-mastoid crest** an inch above and behind the external auditory meatus The temporal fossa cannot be explored with the fingers because of the dense **temporal fascia** which stretches from the upper temporal line to the sharp upper edge of the zygomatic arch.

Below the anterior part of the zygomatic arch the fingers can push the cheek some distance into the front part of the **infra-temporal fossa**, and behind the hollow the mass of the **masseter muscle** can be felt descending from the zygomatic arch over the ramus of the mandible. The articular **condyle of the mandible** can be felt, and sometimes be seen immediately below the zygomatic arch in front of the auricle it moves forwards when the mouth is opened and the finger can then enter the mandibular fossa of the temporal bone behind it. The **coronoid process of the mandible** under cover of the masseter muscle, but it can be felt through the muscle below the zygomatic bone It becomes more prominent when the mouth is opened, and the fingers can then be run down the anterior border of the **ramus of the mandible.** The posterior border of the ramus is masked by the **parotid gland** which covers it but it can easily be followed from below the auricle to the angle of the jaw The outer surface of the **body of the mandible** is accurately palpable through the soft structures that cover it on it is placed the **mental foramen** which transmits the **mental vessels** and

nerve. The foramen lies midway between the upper and lower edges of the adult jaw between the premolar teeth or below the second premolar tooth that is it is on or near the vertical line drawn from the supra-orbital notch (Fig 9)

Reflection of the Skin.—The skin is to be reflected from the forehead and the face. An incision which commences on the scalp at the bregma is to be carried forwards along the middle line of the forehead and downwards on the nose and the upper lip to the mouth and a continuation of this incision is to be made in the lower lip from the mouth to the chin. A circular incision is then to be made round the margin of the orbit the eyelids being left intact and it is to be prolonged from the lateral angle of the eye backwards to the ear A second circular incision is to be made round the mouth along the red margin of the lips, and a transverse cut is to be carried from the angle of the mouth to the angle of the jaw The flaps of skin thus defined are to be carefully raised the lowest flap being turned downwards to the lower border of the jaw and while doing so it will be noted that many of the fibres of the **facial muscles** are inserted into the deep surface of the skin.

The skin of the face varies in thickness, being thinner round the orbits and in the temples and thicker on the forehead, over the lower part of the nose and round the mouth, and specially thick on the chin It is intimately connected to the subjacent connective tissue the connexion being most close on the lower part of the nose over the chin, and in the naso-labial and labio-mental grooves. The former groove lies between the cheek and the nose and lips and runs from above the angle of the nose round the angle of the mouth, and the latter groove lies between the lower lip and the chin; the depth of the grooves varies with the strength of the cutaneo-fascial connexions. Many other grooves appear on the skin when it loses its elasticity with advancing age and it sags under the lower eyelids and over the lower part of the f ce

The skin of the face possesses numerous sweat and sebaceous glands, the latter being liable to inflammatory disturbances especially in adolescents. It is well supplied with blood vessels, bleeds copiously when cut, and heals readily The arterioles have rich sympathetic vaso-motor nerve supply and blushing and blanching readily occur in states of emotion, while the venules are often permanently engorged in those exposed to cold, in alcoholics, and when the circulation is obstructed. The nerve supply of the skin of the face and forehead, except over the angle of the lower jaw and in front of the ear (Fig 18), is through the three divisions of the trigeminal (fifth cranial) nerve, each division supplying well-defined developmental area of it as will be determined later

The facial muscles are embedded in the connective tissue which underlies the skin and they are directly inserted into its deep surface; when they contract they move the skin and connective tissue. The attachment of th muscles to the skin causes wounds of it to gape and they require to be sutured.

The subcutaneous connective tissue is loose and delicat though it often contains a large amount of fat especially in women and children. It is readily infiltrated by inflammatory or dropsical effusions; this is especially so in the

lower eyelid. The tissue over the chin however is much more dense. The facial muscles are embedded in the tissue and if there is much fat are hidden by it.

There are two large groups of muscles in the face (p. 7). One group comprises the **facial muscles** proper or **muscles of expression**, a series of thin ill-defined sheets lying in the loose connective tissue which constitutes the superficial fascia: they arise as a rule from skeletal parts of the face and are inserted, in main part, into the deep surface of the skin. They are all supplied by the facial (seventh cranial) nerve. The other group comprises the **muscles of mastication**, a series of large powerful muscles which are attached to the lower jaw and effect its movements. They are supplied by the mandibular division of the trigeminal (fifth cranial) nerve. The **masseter muscle**, a muscle of this group, will be partly exposed, and lying on and behind it the **parotid gland** covered by the parotid fascia will be seen. The **temporal muscle**, the fore part of which can be recognised under the dense temporal fascia, also belongs to this group of muscles.

It is the **facial muscles of expression** that come under examination in the present dissection. They are, for the most part, thin sheets of pale muscle fibres intermingled with connective tissue bundles, and placed as they are in the loose tissue immediately below the skin are devoid of the proper fascial sheath that normally covers skeletal muscles: there is one exception, however, the posterior part of the buccinator muscle being covered with the bucco-pharyngeal fascia. Each facial muscle takes origin from bone or ligament or strong fascia and is chiefly inserted into the skin, the muscle fibres ending in delicate tendons which form a network in the dermis: insertions also occur into mucous membranes, fibrous plates, and cartilages that are bound to the skin. The muscles take part in the acts of taking food and mastication and they control the entrances to the mouth, orbit, nose, and ear; but much more than any other muscles of the body they are quickened by changes in the affective content of consciousness. The lie and position of the parts of the face induced by them when in a state of rest are thus an expression of the personality, and the movements produced by their contraction are recognisable as expressions of the emotions. It is from their affective activity that they are named the muscles of expression, but it is to be remembered of them that they have also voluntary actions: the movements of expression are usually better on the right than on the left side of the face.

The facial muscles form a continuous sheet in lower Primates and in the early stages of human development. They become individualised in later development but, though there are considerable differences in this process, they usually remain so blended together at their margins that it is not practicable to define the precise extent and attachments of each named muscle. It is much more important to recognise that they are arranged in sets round the openings of the face and, therefore, that they may be described in the following groups:—(a) An oral

group round the mouth forming the substance of the lips and cheeks (*b*) an **orbital group** round the orbital opening and extending into the eyelids (*c*) a **nasal group** attached to the movable cartilaginous parts of the external nose and (*d*) an **auricular group** attached to the cartilage of the auricle. The muscles of each group consist of (*a*) a sphincter muscle which encircles the opening and by which the opening is closed, and (*b*) a dilator muscle or muscles which radiate from the opening and by which the closed opening is opened. The muscles of the nasal and auricular groups are insignificant in size for the openings of the nose and ear are maintained permanently open by the cartilages that surround them and the cartilages can be little altered in position In addition to the groups named above there are thin sheets of the facial musculature extending downward on the neck (the platysma) and upwards over the scalp (the occipito-frontalis) (Fig 13) these two parts will be studied in later dissection

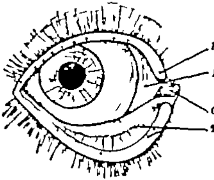


FIG 8

The external parts of the eye The eyelids are drawn apart, the lower lid is everted, and the eyeball is rotated laterally

It is most convenient to commence the study of the facial muscles with the **orbital group** and at the same time to examine the structure of the **eyelids** and the arrangement of the **conjunctiva** and the **lacrimal apparatus.**

The **eyelids** (palpebræ) are two thin movable folds of integument strengthened by plates of dense fibrous tissue (the tarsal plates) the lining of their deep surface is modified to resemble a mucous membrane and is named the conjunctiva. They serve to protect the eyeball and to govern the admission of light to it. The upper lid is the longer and the more movable, and is provided with a special elevating musculature The lids join each other at the **medial** and **lateral angles** of the eye. The free margins of the lids, covered with conjunctiva are flat except close to the medial angle there they become rounded alter their direction, and, extending some distance (5 mm) medial to the eyeball, bound a shallow ⊃-shaped depression named the **lacus lacrimalis** (Fig. 9)

The lacrimal lake contains an irregularly oval reddish elevation, the **caruncula lacrimalis**. It consists of an islet of modified skin which carries a few minute colourless hairs these are provided with large sebaceous and small sweat glands which are embedded in a cushion of fatty tissue. Lateral to the caruncula there is a vertical crescentic fold of conjunctiva the **plica semilunaris** (Fig 9) It is probably the rudiment of the third eyelid or nictitating membrane of crocodiles, birds, and other animals, and often contains a small bar of hyaline cartilage as the vestige of the larger plate present in it in them. The flat parts of the rims of the eyelids carry the eyelashes along their rounded anterior edges while along their sharp posterior edges the minute orifices of the **tarsal** (Meibomian) **glands** are just to be seen on the rounded parts of the rims there are neither lashes nor glands. The interval between the rims of the lids when the eye is open is the **palpebral fissure**. It is an ellipitical opening, not quite symmetrical in shape. There is considerable individual variation in its size, giving the impression of a larger or smaller eye the diameters of the adult eyeball, however are practically constant. When the eyelids are separated to the normal extent the edge of the upper lid lies below the upper margin of the cornea (the clear part on the front of the eyeball) a narrow crescentic area of which it masks and the edge of the lower lid falls a little below the lower corneal margin, a strip of the sclera (the white of the eyeball) being exposed. When the eye is closed the upper lid entirely covers cornea, and the palpebral fissure is a slightly convex line arched downwards opposite the lower margin of the cornea. The palpebral fissure leads into the **conjunctival sac**. *When the lids are shut this is a closed* capillary space between the lids and the anterior surface of the eyeball, extending much higher behind the upper lid than downwards behind the lower lid. The **conjunctiva** on the deep surface of the lids is a rosy translucent highly vascular membrane. It is reflected from the lids onto the eyeball and as a moist transparent membrane covers the sclera at the margin of the cornea it is reduced to an epithelium which covers and blends with its front surface. The reflections from the lids to the eyeball form the fornices of the conjunctiva the reflections are loose enough not to impede the movements of the eyeball.

The eyelids are to be everted and their margins and conjunctival surfaces examined with a lens. The lower fornix is easily exposed but the upper is difficult to examine The **tarsal** (Meibomian) **glands** will be seen through the conjunctiva as parallel yellow streaks on the deep surface of the lids. On the margin of the lids, at the points where the rounded boundaries of the lacus lacrimalis pass into the flat parts, there are small elevations one on each lid the **papillæ lacrimales** the papilla on the lower lid is better seen. The papillæ are perforated by minute openings, the **puncta lacrimalia** (Fig 9) These are the mouths of the **lacrimal canals** by which the tears are normally carried away from the conjunctival sac the papillæ are turned towards the eyeball and are in contact with its conjunctival covering and the puncta dip into the fluid at the medial angle of the eye. A bristle is to be passed into each

opening when it will be found that the upper canal at first ascends and the lower at first descends and then both canals run transversely in the substance of the lids near their margins to the lacrimal sac. (Fig 11)

The eyelashes are short stiff hairs curved away from the surface of the eye ball and directed slightly laterally; they are twice as numerous (100 to 150 in number) on the upper lid and are longest on the centre of the upper lid. They are implanted on the lids in double or triple rows along the anterior edges of the rims where the conjunctiva is continued into the skin; their free ends lie in a single row Close to the follicles of the lashes in the substance of the lids, lie the **glands of Moll** and the **glands of Zeis**. The former are coiled tubules, resembling modified sweat glands, while the latter are sebaceous glands the ducts of which open close to or into the mouths of the lash follicles; a stye is a suppuration of one of the sebaceous glands.

The **epicanthic or Mongolian fold** is a crescentic fold of skin which crosses the medial angle of the eye from th upper to the lower lid and wholly or partly covers the lacus lacrimalis. It is a normal struct re in the foetus and it or a rudiment of it is to be seen in many children before the bridge of the nose is fully developed it persists in the Mongolian races as a characteristic feature

The **conjunctiva** is a modified skin but bathed continually as it is with th tears assumes the general appearance of a mucou membrane On the eyelids it is firmly adherent to the tarsal plates but beyond them it becomes loose and, except in the young, is thrown into small folds; it contains here some lymphoid tissue and small accessory lacrimal glands. On the eyeball it is thin, transparent and unwrinkled and much less vascular; it is very loosely attached to the sclera and the sub-conjunctival blood vessels being feebly supported rupture easily as, for example in a paroxysm of coughing. It gradually becomes thinner towards the margin of the cornea and its epithelium alone is continued over it.

The **tarsal (Meibomian) glands**, about thirty in the upper lid and twenty in the lower lid, are lodged in a row on the deep surface of the tarsal plates under cover of the conjunct va. They are modified sebaceous gland of large size and secrete fatty substance which is discharged through the minute penings of the ducts on the margins of the lids; the margins are thus kept lubricated and so better act as an effective barrier in normal conditions, against the escape of tears from the conjunctival sac

The skin is to be reflected from the eyelids as far as their margins. It is the thinnest skin in the body It carries a few scattered very fine hairs and small sweat glands. It is marked by numerous transverse creases and in the aged vertical furrows also occur Near the medial angle it is pigmented especially on the lower lid and often sufficiently to give it a brown colour Below the skin there is a very loose connective tissue distinguished by the entire absence of fat in it lies the palpebral part of the **orbicularis oculi muscle**.

The **medial palpebral ligament** attaches the medial ends of the eyelids to the lacrimal crest of the frontal process of the *maxilla* (Fig) It is made tense and brought into prominence as a ridge by pulling the

eyelids towards the temple this the student is to do on the subject and then feel the ligament, as a cord-like horizontal band, between the medial angle of the eye and the nose. He should also palpate it on himself. It will be exposed after the orbital muscles are examined. These muscles are the **orbicularis oculi** which surrounds the orbital margin and extends into the eyelids, the **frontalis** which lies above the orbit and extends upwards on the forehead, and the **corrugator supercilii** and the **procerus** which are two small deep muscles at the medial end of the eyebrow. The orbicularis and frontalis muscles are to be cleaned care being taken to preserve the supra-orbital supra trochlear and infra trochlear nerves which pierce them (Fig. 16).

The **orbicularis oculi** (Fig. 13) lies in part in the substance of the eyelids (palpebral part) and in part, beyond them, round the margin of the orbital opening (orbital part). It consists of fibres arranged concentrically but it will be noted at once that the palpebral part is thinner paler in colour, and finer in texture, and that the peripheral bundles of the orbital part are scattered among and connected with the adjacent muscles. The fibres of the palpebral part arise from the superficial and deep surfaces of the medial palpebral ligament but not from its lower edge, and sweep laterally over the eyelids under the skin forming a layer of uniform thickness. At the lateral angle of the eye the fibres from the upper and lower lids interlace and form the lateral palpebral raphe. A bundle of very fine fibres lies close to the margin of each lid, deep to the bulbs of the eyelashes; it is named the ciliary bundle. The orbital part arises from the medial palpebral ligament and the neighbouring areas of the frontal process of the maxilla and the nasal process of the frontal bone. Its fibres sweep laterally in concentric elliptical loops, reaching upwards onto the forehead, downwards onto the cheek, and laterally into the temporal region, and in great part pass uninterruptedly round the orbital circumference. It is only in the eyebrow and the medial part of the lower lid that they are directly attached to the deep surface of the skin. (A third part of the muscle, the pars lacrimalis, will be dissected later; it lies deep to the lacrimal sac.)

The **occipito-frontalis** is a broad musculo-tendinous sheet which, as part of the scalp, covers the skull from the occipital region to the supra-orbital margins and the root of the nose. It has two muscular parts, an occipital part behind and a frontal part in front and these are connected by an aponeurotic tendon, the epicranial aponeurosis. The frontal muscular part consists of the two **frontalis muscles** (Fig. 13). Each frontalis muscle is thin, quadrilateral in form and intimately blended with the superficial fascia; it has no attachment to bone except laterally where it is loosely connected to the temporal ridge by areolar tissue. Its fibres emerge from the epicranial aponeurosis in front of the coronal suture and pass downwards over the forehead; they are inserted into the skin of the forehead the lateral fibres mingling with the orbicularis oculi and the most medial fibres being continued onto the root of the nose and mingling with the procerus muscle. The medial margins of the frontales are joined together for some distance in the lower part of the forehead. Each muscle is pierced by the supra orbital and supra-trochlear vessels and nerves above the eyebrow.

The **corrugator supercilii** (Fig. 13) is a small muscle placed deep to the frontalis and orbicularis oculi at the medial end of the eyebrow and is to be

exposed by dividing these muscles It arises from the medial end of the superciliary arch and passes laterally and slightly upwards to be inserted into the skin of the middle of the eyebrow It is a specialised part of the orbicularis oculi.

The procerus muscle (Fig 13), although placed over the root of the nose belongs to the ocular group of muscles It appears indeed to be a downward continuation of the medial part of the frontalis It arises below from the aponeurotic fascia over the lower part of the nasal bone and the upper part of the lateral nasal cartilage; and it is inserted into the skin between the eyebrows, it fibres interlacing with the frontalis

The Action of the Orbital Muscles.—The eyelid are gently brought together as in sleep and involuntary winking by the palpebral part of the orbiculari oculi, the upper lid moving much more than the lower lid. In these movements both lids are drawn medially towards the fixed attachment of the muscle and so carry the tears to the medial angle of the eye Forcible closure of the lids as when the eyes are exposed to glaring light or external danger is effected by the cooperation of the orbital part of the muscle the corrugator supercilii, and the procerus. The skin round the orbit is then forcibly drawn towards the medial angle the eyebrow being depressed the skin above the root of the nose being drawn down, the cheek being raised and the lower lid pulled upwards, and the skin of the temple being drawn forwards a complex system of skin wrinkles is established in these parts and a fold is formed round the orbit to give more protection to the eyeball. This action of the muscles also occurs in the strong expiratory effort of coughing and crying and, compressing the contents of the orbit, prevents over-distension of the orbital veins. The frontalis muscle is the general antagonist to the sphincter muscles. It elevates the eyebrow and in forcible contraction causes transverse wrinkles on the forehead. A special elevator muscle of the upper lid will be dissected later

The orbital muscles are freely used in the expression of psychical states. The sphincter muscles act in states of attention, concentration, mental difficulty irritability and anger and the elevating (dilator) muscle in states of surprise doubt fright, and horror

The dissection of the **eyelids** is to be completed at the present time. The palpebral parts of the orbicularis are to be separated from the orbital parts and removed from the lids, care being taken in raising the muscle fibres to avoid injury to the underlying **palpebral fascia** and **tarsal plates** (Fig 10) These structures lying in the same plane form the framework of the eyelids. They are lined on their deep surface by the conjunctiva which is closely adherent to the tarsal plates. The **medial palpebral ligament** is to be cleaned and defined by cutting away the fibres of the orbicularis which are attached to its surface.

The **tarsal plates**, formed of dense fibrous tissue are placed in the eyelids close to their free margin and maintain their rigidity and form (Figs. 10 and 11). Each plate is about 2 5 cm. long and 1 mm. thick, but the upper—a half oval in shape—is much broader than the lower which is merely a crescentic strip; the marginal borders are relatively straight and a little thickened The plates are connected to the bony margin of the orbit by the **palpebral fascia** and the **palpebral ligaments**. The fascia is a thin layer of connective tissue (Fig 10). It materially strengthens the lids and prevents the orbital fat projecting

forwards into them. In the upper lid it is blended with the underlying tendon of the levator palpebræ superioris, and is carried downward with it over the *anterior surface of* the tarsal plate to which it is, in part, attached; close to the supra-orbital margin it is pierced by the lacrimal, supra-orbital, supra-trochlear and infra-trochlear vessels and nerves (Fig. 10). On the medial side the fascia passes deep to the lacrimal sac and is attached to the posterior margin of the groove in which it lies. In the lower lid the palpebral fascia is continuous with the lower margin of the tarsal plate (Fig. 10). The pointed ends of the tarsal plates are joined to the palpebral ligaments. The lateral palpebral ligament is a narrow but definite band which is attached to a tubercle

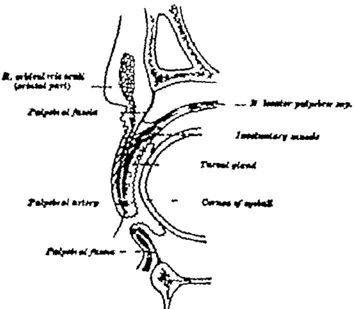


FIG. 10.

A diagram of a vertical section of the eyelids. The tarsal plates are in solid black and the conjunctiva is waved line.

on the frontal process of the zygomatic bone just within the orbital margin; usually between it and the more superficial lateral palpebral raphe of the orbicularis muscle there are some lobules of lacrimal gland. The medial palpebral ligament is much stronger band; it is attached to the lacrimal crest on the frontal process of the maxilla. When it is cleaned of the fibres of the orbicularis which arise from its surface it will be seen to have thick rounded lower border but it becomes thinner and even ill-defined above; it is the lower border which is palpated in the living subject when it is made tense. The ligament covers the upper half of the lacrimal sac which is separated from it, however by layer of fascia and some fibres of the orbicularis oculi.

The palpebral fascia of the upper lid is to be removed to expose the underlying tendon of the levator palpebræ superioris. This muscle

arises within the orbit and extends into the upper lid as a broad glistening aponeurosis. It blends there with the palpebral fascia and sweeping over the front of the tarsal plate splits into numerous fine bundles most of which penetrate the orbicularis and are ultimately fixed to the skin; some bundles are attached to the lower third of the face of the tarsal plate. The lateral margin of the aponeurosis cuts into the lacrimal gland which is, as it were, folded round it, and by a horn-like extension it is fixed with the lateral palpebral ligament to the zygomatic bone. The medial margin of the aponeurosis is attached by loose strands to the medial palpebral ligament. The levator palpebræ superioris is supplied by the oculo-motor (third cranial) nerve.

The levator palpebræ superioris is the elevator of the upper lid and is therefore the antagonist of the palpebral part of the orbicularis oculi; its over-action is prevented by the fixed attachments of the expansion of the lateral and medial margins of its aponeurosis. It is probable, however, that having elevated the lid it alone does not maintain it in the raised position; it is at least assisted by "the involuntary palpebral muscle" (of Müller). This muscle is a thin slip of pale unstriped muscle fibres which is attached above to the deep surface of the aponeurosis of the levator and below to the upper margin of the tarsal plate (Fig. 10); there is a similar slip of muscle in the lower lid, also attached to the margin of the tarsal plate. Both slips are probably supplied by sympathetic nerves.

The following layers have now been exposed in the eyelids: (1) the skin; (2) the loose subcutaneous areolar tissue; (3) the palpebral parts of the orbicularis oculi; (4) the tarsal plates and the palpebral fascia and ligaments, and in the upper lid the aponeurosis of the levator palpebræ superioris; and (5) the conjunctiva, and, between it and the tarsal plates, the tarsal glands.

The arteries of the eyelids are the medial and lateral palpebral arteries, one vessel entering each lid at each of its extremities. The medial vessels are branches of the ophthalmic artery while the lateral arise from the lacrimal artery, itself a branch of the ophthalmic artery. The vessels anastomose with one another, forming a tortuous arterial arch in each lid close to its margin between the orbicularis muscle and the tarsus; from the arch twigs are given to the several layers of the lid. The veins from the conjunctiva and the tarsal glands join the ophthalmic veins of the orbit, while the superficial veins for the most part run medially and terminate at the medial angle of the eye in the frontal and angular veins. The sensory nerves of the upper lid are derived from the *supra-orbital, supra-trochlear* and *infra-trochlear* branches of the ophthalmic division of the trigeminal nerve, and those of the lower lid come from the infra-orbital branch of the maxillary division of the same nerve. The main trunks of the nerves lie between the tarsal plates and the orbicularis muscle and from them twigs are given to the skin and the conjunctiva.

The **lacrimal apparatus** (Fig. 11) is to be examined at the present time. It comprises the **lacrimal gland**, the secretion of which (the tears) is poured by the **ducts** of the gland into the lateral part of the superior fornix of the conjunctival sac. The tears are then carried,

by the *movements* of the upper eyelid over the *surface* of the eyeball to the medial angle where any excess that has not been removed by evaporation passes through the **puncta lacrimalia** into the **lacrimal canals** and in them is conveyed to the **lacrimal sac**. The lacrimal sac is drained by the **naso-lacrimal duct** which leads into the lower part of the nose. When the *secretion of the lacrimal gland is too abundant* to be drained away it overflows from the lids as the perceptible tears.

The **lacrimal gland** is to be exposed by cutting through the palpebral fascia at the upper and lateral angle of the orbit It will then be seen

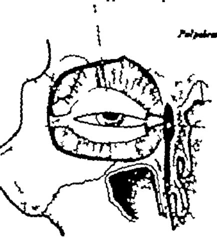


FIG. 11

A dissection of the lacrimal pparatus The palpebral fascia of the upper lid is t prese he *palpebral part of the lacrimal gland* The tarsal plates are t be coloured)

to lie n the orbital cavity under cover of the lateral angular process of the frontal bone and to extend int the upper eyelid.

The lacrimal gland is placed in the upper and lateral part of the orbit. It is about the size of small lmond and yellowish in colour The lobules of the gland are bou l t gether by connective tissue. The pper surface is convex and is lodged in lepression on the orbital face of the frontal bone, while the lower surfa moulded t the convexity of th eyeball. The under part of the , and is t int by the lateral expansion of the aponeurosis of the levator palp brae superioris ; the part below the expansion extends into the upper eyelid nd is losel adherent t t deep surface, being covered only by the conjunct va t reflected from the lid on to the eyeball. The ducts of the gland vary in number—there are seldom more than twelve—and may be seen as fine white t bules if the anterior border of the gland is gently

raised upward and the loose tissue below it carefully teased. They open in a row into the upper lateral part of the conjunctival sac (Fig 11)

Many small accessory lacrimal glands are present in the conjunctival fornices; they are more numerous in the upper lid.

The secretion of the lacrimal gland having reached the medial angle of the eye is drained by the lacrimal passages. These commence as the **lacrimal canals** which open on the free margin of the lids at the **puncta lacrimalia**. Small bristles should again be passed through the puncta into the canals and along them into the **lacrimal sac**. The medial palpebral ligament is to be cut away to expose the upper part of the lacrimal sac which lies behind it.

The **lacrimal canals** commence at the puncta lacrimalia on the summits of the lacrimal papillæ The upper duct at first ascends and the lower duct at first descends, and then bending acut ly on themselves both run medially in the margins of the lids round the lacus lacrimalis to the lacrimal sac The canals are about 10 mm long The orifices on the puncta are only 0 1 mm in diameter but at the angles of bending there are d lated part 1 mm. wide beyond them the ducts are bout 0 5 mm in diameter The ducts are larger in men than in women nd can drain much larger excess of tears.

The **lacrimal sac** (Fig 11) i the upper end of the passage that leads the collected tears into the nose where they are evaporated in the respiratory currents. The sac is lodged on the medial wall of the orbit in the deep lacrimal groove formed by the lacrimal bone and the frontal process of the maxilla. It is about 15 mm. long and 5 mm. wide and conforms in shape to the groove, tapering a little above at its closed end. It is immediately covered by a strong fascia which is attached to the edges of the groove, and its upper part is overlaid in front by the medial palpebral ligament the pars lacrimalis of the orbicularis oculi muscle passes deep to it and its covering fascia from the lateral side. The anterior wall of the sac is to be opened and a probe passed down the naso-lacrimal duct into the nose. This duct will be seen in a later dissection but it should be noted t present that it is about half an inch long and that it is inclined backwards and laterally in it downward course; the opening of the duct in the inferior meatus of the nose is guarded by a valve of mucous membrane the plica lacrimalis.

The **pars lacrimalis** of the orbicularis oculi is a deep slip of the palpebral part of the muscle It arises from the lacrimal crest of the lacrimal bone, deep to the lacrimal sac nd from the fascia that covers the sac. Its fibres pass laterally deep t the lacrimal canals, and terminate in the eyelids where they mingle with the fibres of the ciliary bundles The muscle keeps the margin of the eyelids in contact with the eyeball and th puncta lacrimalia turned inward int the lacus lacrimalis.

The **external nose** and the feeble muscles related to it are now to be examined.

The skeleton of the upper part of the nose is formed by the **nasal bones**. They vary greatly in their shape and size. At first in development they are broad and short and sunken in position and they remain so in infancy but in Europeans they normally elongate at puberty

and become more prominent. They lie side by side in the bridge of the nose articulating with one another in the middle line and with the frontal bone above (Fig. 2). The **fronto-nasal suture** lies in the depression at the root of the nose the mid point of the suture is the **nasion**, and above it is the **glabella** of the frontal bone. Each nasal bone rests behind on the **frontal process of the maxilla**. The bony nasal aperture, as it exists in the dried skull is bounded by the thin notched lower border of the nasal bones and the nasal margins of the maxillæ It can easily be palpated in the living. The lower movable part of the nose, formed of the **nasal cartilages** and dense fibrous tissue, is attached in a slight depression to the margin of the bony aperture. It is perforated below by the two large elliptical **nostrils** which are separated from

FIG. 12.

The skeleton of the nose. The following parts are to be named the nasal bone, the frontal process of maxilla, the nasal spine, the glabella, and the nasion.

one another by the *columna naris*, the lower freely movable part of the septum between the two nasal cavities below the columna there is a broad groove in the upper lip, the **philtrum**. The back part of the columna is supported by the **nasal spine** of the maxilla which can be felt if the finger is placed on the middle of the philtrum and pressed upwards. The **vestibule** of each nasal cavity is the part within and above the nostril It is lined with skin which carries hairs. The lateral wall of the vestibule is the ala of the nose it is slightly expanded and is limited above by light groove. The alæ are the parts of the nose most under the influence f the nasal muscles.

The external nose is the beginning of the respiratory tract and leads backwards into the nasal cavities. It is distinctive feature of Man. It varies greatly in size and shape; the minor differences are among the marks of

personal distinction but the major differences are of sufficient importance to be used in the classification of races. In the fœtus it is short and wide the bridge is sunken and concave and the nostrils face forwards; this fœtal form persists in some races and may be maintained in Europeans as a result of faulty development

The skin covering the bony part of the nose is thin and freely movable over the cartilaginous part it is thicker and closely bound to the underlying fibrous tissue which, except over the alæ is almost devoid of fat. The skin carries delicate hairs and numerous sweat and sebaceous glands on the alæ the sebaceous glands are of exceptional size and the orifices of their ducts are to be seen as minute depressions.

The muscles of the nose are small, often rudimentary and ill-defined and the student should not attempt a detailed dissection of them. They comprise the compressor naris and the dilator naris. They arise from the facial surface of the maxilla by the side of the nasal aperture the compressor above the dilator the origin being covered by the muscles of the upper lip (Fig 13). The compressor ends in a thin aponeurosis which covers the mobile part of the nose and is continuous over it with the aponeurosis of the opposite side; the aponeurosis is closely attached to the skin but only loosely to the underlying cartilages. The dilator consists of short fibres attached to the skin of the back of the ala. These muscles act as their names imply in moving the boundaries of the nostrils; they take part in modifying the facial expression and act spontaneously in difficult and excited breathing

The muscles and fibrous coverings are to be removed from the nose to expose the **nasal cartilages**. While this is being done care is to be taken to secure the **external nasal nerve** it emerges between the lower border of the nasal bone and the upper lateral nasal cartilage and accompanied by a small artery passes downwards under cover of the aponeurosis of the compressor naris.

The cartilaginous framework of the nose consists of five main cartilages, namely the septal cartilage which forms part of the partition between the nasal cavities and will be studied in a later dissection, and the upper and lower lateral cartilages on each side (Fig 12). These cartilages are connected to one another and to the bony aperture of the nose by dense fibrous tissue.

The **upper lateral cartilage** is triangular in shape and lies immediately below the nasal bone to the lower margin of which its upper border is attached. The cartilages of the two sides meet the anterior border of the septal cartilage in the middle line and their upper parts fuse with it; the lower parts are connected to it by fibrous tissue which obliterates the groove between them. The lower border of the cartilage is connected to the lower cartilage by fibrous tissue. The **lower lateral cartilage** is folded round the front and side of the nostril. In front the cartilage meets its neighbour of the opposite side and forms the point of the nose, and from it a narrow strip runs backwards along the lower margin of the septal cartilage and acts as a support for the medial side of the nostril. On the side of the nose the cartilage is of uncertain size and shape, but it does not reach the maxilla behind or the lower border of the ala of the nose below; the interval is filled with dense fibro-fatty tissue in the upper part of which there are two or three small accessory cartilages (Fig. 12).

The **oral muscles** lie in the lips and the cheeks and form a large part of their substance. They are arranged in the two typical sets (p. 25) namely (1) a circular muscle, the **orbicularis oris**, which lies in the lips round the orifice of the mouth and acts as a sphincter or closing muscle, and (2) a series of muscles that converge on the orifice from above, from the sides, and from below and act as opening muscles (Fig. 13). The opening muscles are in two layers, a superficial and a deep layer. They take origin in the peripheral parts of the cheeks from the maxilla, the zygomatic bone and the mandible or from ligamentous or fascial structures related to them, and their fibres pass towards the orbicularis along lines at right angles to tangents to it and all of them—except the mentalis, a deep muscle on the chin—are continued into the orbicularis, form part of its substance and are inserted into the skin and mucous membrane of the lips. It is unnecessary for the student to make more than a general examination of them in the following groups.

(A) The superficial muscles that enter the upper lip from above and act as elevators of it are the **levator labii superioris alaeque nasi**, the **levator labii superioris**, the **zygomaticus minor**, and the **zygomaticus major**. They arise, in that order from the medial to the lateral side, from the maxilla and the zygomatic bone along the infra-orbital margin; their upper parts are covered by the orbicularis oculi. They pass towards the upper lip with an increasing obliquity, the zygomaticus major reaching the angle of the mouth, and are inserted into the lip in the manner described above; the first muscle detaches a medial slip that is inserted into the skin of the ala of the nose and some fibres of the zygomaticus major enter the lower lip. These muscles are to be recognised and then named on Fig. 13.

(B) The superficial muscle whose fibres converge on the angle of the mouth is the **risorius** (Fig. 13). It consists of a varying number of muscle bundles arising from the fascia over the masseter muscle and the parotid gland. It lies superficial to the platysma, but is usually blended with its uppermost fibres which, like it, join the orbicularis at the angle of the mouth and are inserted into the skin of both lips.

(C) The superficial muscles that ascend into the lower lip from below are the **depressor anguli oris** and the **depressor labii inferioris**; and they are supplemented by a part of the **platysma**. The two depressor muscles arise from the oblique line on the body of the mandible and, the former overlapping the lateral part of the latter (Fig. 13), they ascend into the lip and mingle with the orbicularis; the angular muscle sends some fibres into the upper lip.

The **platysma**, as will be seen in the dissection of the neck, arises from the skin and the fascia covering the upper part of the pectoralis major and deltoid muscles. It ascends in the superficial fascia of the neck and enters the face over the lower border of the mandible. The greater part of the muscle is inserted into the outer surface of the mandible near its lower border from the mental protuberance to the anterior edge of the masseter, the most medial fibres decussating with those of the opposite side; but the most lateral fibres cross over the side of the face and curve forwards to the angle of the mouth where they are inserted into the skin of both lips.

The deep radial muscles are now to be dissected and while they are being sought and defined every care is to be taken to preserve the

vessels and nerves of the face The muscles to be studied are the **levator anguli oris** and the **buccinator** The zygomaticus major is to be cut near its origin and turned downwards it crosses the masseter muscle and then a pad of fat, the **buccal pad**, which fills the fossa in front of the masseter and close to the mouth it overlies the **facial artery** The zygomaticus minor is simply to be divided it also overlies the facial artery The relation of the artery *to the levator labii superioris* is variable it may be superficial or deep to it or in it substance but in whatever position it is it is to be dissected from the muscle and the

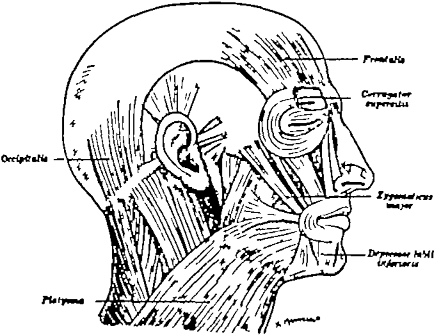


Fig. 13.

The muscles of the face The unnamed muscles are to be identified and named.

muscle is to be turned downwards Deep to the muscle there is some fat in which the **infra-orbital vessels** and **nerve** are to be found they issue from the infra-orbital foramen and descend on the levator anguli oris. This deep muscle is then to be cleaned.

The depressor anguli oris and the risorius are to be cut near their origin and the back part of the platysma is to be divided along the lower border of the mandible. The three muscles are then to be reflected towards the mouth the facial artery lies *deep to them*. The **buccal pad of fat** is to be examined it lies on the surface of the buccinator It is to be picked away with forceps the **duct of the parotid gland** and the **buccal nerves** which pierce it being preserved round the duct

there are four or five small **molar salivary glands** for which search should be made. The back part of the buccinator is covered by the **bucco-pharyngeal fascia** this it to be removed that the origin of the muscle from the maxilla and the mandible (Fig 1 where it is shown in solid black lines) may be defined and its fibres traced forwards to the angle of the mouth. Two or three **buccal lymph glands** lie on the fascia but it is improbable that they will be found.

The levator anguli oris is covered by the orbicularis oculi, the levator labii superioris, and the zygomatic muscles and more immediately by a layer of fat in which lie the infra-orbital vessels and nerve it is crossed superficially near the angle of the mouth by the facial artery It arises from the canine fossa of the maxilla just below the infra-orbital foramen and it passes to the angle of the mouth; it blends there with the orbicularis oris, some of its fibres passing into the lower lip

The buccinator (Fig 91) is a thin sheet of muscle which lies in the cheek in the interval bet een the upper and lower jaws, thus forming a considerable part of the wall of the mouth; it is in contact with its mucous membrane. Its origin is ⊂-shaped and comprises the alveolar processes of the maxilla and mandible opposite the molar teeth above and below (Fig. 1) and the pterygo-mandibular ligament behind; the ligamentous attachment will be studied in a later dissection for the back part of the muscle cannot yet be seen. The fibres of the muscle are directed forwards and converge on the angle of the mouth. The superficial fibres are continued int the lips and mingle with the orbicularis, there being some crossing of bundles from above and below; the deep fibres are inserted into a vertical musculo-tendinous septum which lies bout 1 cm. lateral t the angle of the mouth (see below). The upper back part of the muscle is pierced by the parotid duct.

The buccal pad of fat overlies the back part of the buccinator, filling the interval between it and the masseter and contributing t the substance of the cheek in front of that muscle. It is relatively much larger in the infant and gives the rounded fullness to the heek; probably it aids the action of sucking. The pad of fat is enclosed in a capsule of fascia. It is pierced by the parotid duct and traversed by the buccal nerves. The **molar salivary glands**, four or five in number lie deep to the buccal pad on the bucco-pharyngeal fascia round the terminal part of the parotid duct; they are mucous glands. Their ducts pierce the fascia, the buccinator and the mucous membrane and open int the mouth.

The student will have appreciated that the **orbicularis oris** is a complex muscle. He need do no more however than understand a general description d make a superficial dissection of it.

The orbicularis oris is an elliptical sheet of considerable thickness; it forms, with some fibro-fatty tissue, the foundation of the lips. It reaches above to the base of the nose and below t the labio-mental groove. It consists essentially of arched bundles of fibres that are ttached laterally beyond the angle of the mouth, t vertical musculo-tendinous septum and from it pass transversely int the lips as far the middle line; there are thus four systems of orbicularis fibres, two in each lip. The septum is partly of the nat re of a muscular raphe and intervenes between the orbicularis and the radiating

muscles that converge on the angle of the mouth, more especially the buccinator; it can be felt a a firm vertical thickening in the cheek 4 cm. long and about 1 cm. lateral to the angle of the mouth (Fig 14). The two systems of muscle fibres in each lip meet and decussate in the middle line and, some fibres passing a considerable distance into the opposite side of the lip, are attached superficially to the skin and deeply to the mucous membran There is a special marginal part of the muscle under the red part of the lip; it is well developed in the infant and has been named M. suctionis. These proper fibres of the orbicularis are interwoven with (1) fibres hat enter the lips from above the sides, and below and gain attachment to the skin and mucous membrane there and (2) fine fibres, only to be seen in microscopic examination, that pass obliquely between the skin and the mucous membrane

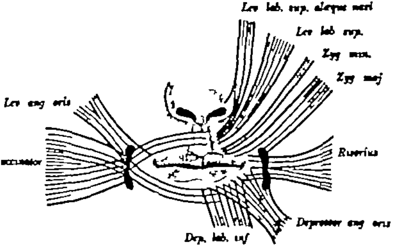


Fig 14

A scheme of the arrangement f the ral muscles. The superficial muscles are shown on one side and the deep muscles on the other; the platysma is not represented. The musculo-tendinous nodes are in solid black.

The lips are to be everted to display the mucous membrane on their deep surface and an incision is to be made through one cheek from the angle of the mouth that its deep surface may also be seen. At the roots of the lips and the cheeks their mucous membrane is reflected onto the gums there being a fold of it in the middle line of each lip, the **frenulum labii** the frenulum of the upper lip is the larger The lips and the cheeks are the external boundaries of the **vestibule of the mouth** it is the space between them and the gums and the teeth. The **duct of the parotid gland** opens into the vestibule opposite the second upper molar tooth the opening is on a small papilla which is to be sought. The mucous membrane is to be reflected from the lower lip As this is done the **labial glands** will be seen The student is then to establish the fact that the orbicularis oris muscle has deep slips of attachment to the mandible below the lateral incisor teeth these are the **inferior incisive muscles**, and between them the **mentalis muscle**

will be seen if the lower lip is dissected further downwards. There are also incisive muscles in the upper lip attached above the lateral incisor teeth, and further in the middle line there is a slip of attachment onto the lower margin of the septum of the nose; the slip is the **depressor septi**.

The **labial glands** are mucous salivary glands about the size of a pea which are closely set in the submucous layer of the lips (Fig. 15); the student can feel them on himself as small ridges by pressing the tongue against the inner surface of the lips. Their ducts pierce the mucous membrane and open into the vestibule of the mouth.

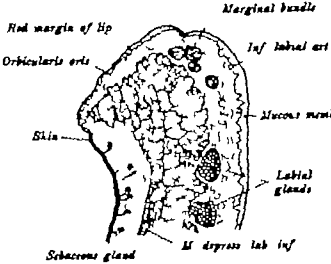


Fig. 15

A vertical section of the lower lip of man.

The **mentalis** is a small but distinct muscle which lies at the side of the frenulum of the lower lip. It arises from the mandible below the incisor teeth, under cover of the depressor labii inferioris, and descends to be inserted into the skin of the chin.

The Action of the Oral Muscles.—The muscles of the lips and cheeks act with the muscles of mastication and the muscles of the tongue in all movements of prehension and mastication of food; the several muscle groups are intimately co-ordinated in these complex acts. More particularly the oral muscles play the main part in all acts of suction, they control the accumulation of fluid foods in the mouth, and by their pressure on solid foods they keep them between the teeth during mastication. They also act in the final movements of speech, their co-operation with one another in these being of the closest kind; and they regulate the forced expulsion of air from the mouth as in whistling. They also act most effectively [illegible] and in all states of emotion, it being impossible entirely to mask their activity; and the

movements they produce may be of intricate delicacy a in controlled intellectual disdain or of simple immensity a in hearty laughter

The oral muscles are bilateral muscles, that is, the muscles of the two sides act together and in health antagonise one another; if facial nerve of one side is injured, however the muscle balance is destroyed and the mouth is drawn to the unaffected side

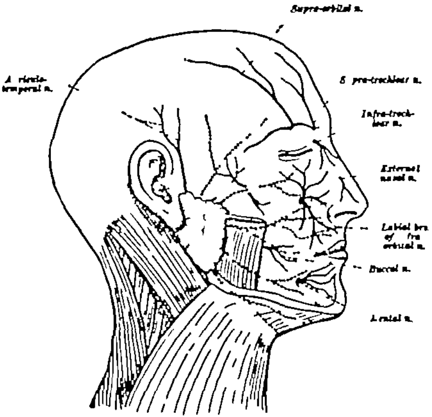


Fig 16.

A diagram of the nerves of the face The branches of the trigeminal nerve are in solid lines and those of the facial nerve in dotted lines. The zygomatic branches of the maxillary nerve are not named. The parotid gland and its duct are shown.

The superficial **vessels** and **nerves of the face** are now to be studied the muscles being cut through as much as is necessary to expose the trunks and follow the branches to their distribution. The **facial artery** and the **anterior facial vein** will be seen in parts of their course but they should not be cleaned until the nerves, which are more liable to be cut have been secured

There are two sets of **nerves** distributed in the superficial parts of the face, namely the **motor nerves** of the muscles of expression and the

sensory nerves of the skin of the face. The motor nerves to all the muscles of expression are branches of the **facial** (seventh cranial) **nerve.** They appear at the margins of the parotid gland and from there spread over the face (Fig. 16) The sensory nerves are derived from the three divisions of the **trigeminal** (fifth cranial) nerve, each division being distributed to a precise area of the skin of the face (Fig. 18). The branches of the ophthalmic (first) **division** supply the skin of the forehead and nose, those of the maxillary (second) **division** supply the skin over the upper jaw and the malar bone and the **mandibular** (third) **division** is distributed over the mandible and over and above the parotid gland. The branches of the fifth and seventh nerves anastomose with one another and form plexuses over the upper and lower jaws.

The fascia which covers the parotid gland is to be incised longitudinally from the zygoma to the angle of the lower jaw immediately in front of the auricle. If it is then raised from the gland, upwards, downwards, and forwards to its margins, the **branches of the facial nerve** will be secured as they emerge from below the gland (Fig. 16) and the **duct of the parotid gland** will be found emerging from its anterior border about half an inch below the zygoma. The duct is to be followed across the masseter muscle it is thick walled and of considerable size At the anterior border of the muscle the duct turns at right angles, and having passed through the buccal pad of fat and pierced the buccinator muscle opens into the mouth (Fig. 52) The **transverse facial artery and vein** and the **zygomatic branches** of the facial nerve are to be secured and followed forwards between the duct and the zygoma, and below the duct the **buccal and mandibular branches** of the nerve are to be dissected out. At the upper end of the parotid gland the **superficial temporal vessels** are easily secured in their course upwards to the scalp (Fig 17) The **auriculo-temporal nerve,** a branch of the third division of the fifth nerve lies very close to them behind, while in front of them there are the **temporal branches** of the facial nerve At the lower end of the parotid gland the **posterior facial vein** and the **cervical branches** of the facial nerve are to be secured. It is then convenient to clean the **facial artery** and its branches and the **anterior facial vein.**

The **facial** (seventh cranial) **nerve,** having emerged from the skull through the stylo-mastoid foramen, enters the deep surface of the parotid gland from behind In the substance of the gland it passes forwards and becoming more superficial crosses the neck of the mandible It then breaks into an irregular series of branches These branches emerge from the margin of the gland above, in front and below and are named according to the region to which they are distributed (Fig. 16) They all terminate in the muscles of expression, communicating in their course with one another and with the branches of the fifth nerve the latter carries the sensory fibres of the muscles. The **temporal branches,** which are of larger size emerge from the upper border of the gland, and crossing over the zygoma in front of the superficial temporal artery are distributed to the orbicularis oculi, frontalis, and corrugator supercilii muscles. The zygomatic branches are of small size. They pass

forwards over the masseter muscle above the parotid duct and supply the orbicularis oculi. The buccal branches, which are large nerves, run horizontally forwards and are distributed below the orbit and round the mouth. The superficial branches cross the superficial muscles of the face and supply them and the procerus muscle on the nose Th deep branches pass under cover of the zygomaticus and levator labii superioris and form an intricate plexus with the labial branches of the infra-orbital nerve; they supply the muscles of the upper lip, the buccinator and the orbicularis oris. The mandibular branch runs along the axis of the lower jaw beneath the platysma as far as the chin. It supplies the muscles of the lower lip and anastomoses with the mental branch of the mandibular division of the fifth nerve which issues through the mental foramen. The cervical branch emerges from the lower end of the parotid gland and runs forward under cover of the platysma below the angle of the jaw to the front of the neck. It will be seen in the dissection of the neck to supply the platysma muscle.

The **facial nerve** is often injured or functionally deranged at or after its exit from the stylo-mastoid foramen. The student will readily understand the signs of such a lesion namely (1) the face is drawn towards the unaffected side ( ) the affected side remains motionless when voluntary movement is attempted for example the eye cannot be shut tears do not enter the lacrimal ducts because the puncta are not in contact with the conjunctiva the ala of the nose does not move in forced respiration the lips cannot be put together for whistling during mastication food accumulates in the cheek fluids escape between the lips, and the labial sounds of speech become blurred (3) the affected side does not share in emotional movements and (4) the lines on the skin produced or partly produced by the facial muscles, for example the lines on the forehead and the naso-labial groove, are smoothed out.

The **facial artery** is the main source of the blood supply of the facial muscles and the superficial layers of the face. There are a number of accessory vessels namely the **transverse facial artery** and a series of small arteries, the **supra-orbital, infra-orbital, mental,** and others, which accompany the branches of the fifth nerve (Fig 17) the small arteries will be exposed when the nerves they accompany are dissected.

The **facial artery** (*Fig* 17) *arises in the neck from the external carotid* artery and enters the face by crossing the lower border of the mandible just in front of the masseter muscle; its pulsations can be felt there against the bone. It has at first an oblique course across the face towards the ala of the nose, resting on the buccinator and levator anguli oris and being covered by the platysma, risorius, and zygomatic muscles and crossed by the superficial buccal branches of the facial nerve. It then takes an almost vertical course towards the medial angle of the eye, passing either over or through or under the levator labii superiori ; the terminal part of the artery known as the **angular artery** runs in the substance of the levator labii superioris alæque nasi and at the medial angle of the eye anastomoses with branches of th ophthalmic artery The facial artery is tortuous in its course and so accommodates itself of the movements of the jaws, cheeks, and lips.

The branches of the facial artery arise from both its posterior and anterior sides. The posterior branches are small. They pass backwards across the buccinator and masseter muscles and end in anastomoses with the transverse facial artery. The anterior branches are much larger. They pass forwards across the face, anastomosing freely with one another and in the middle line with those of the opposite side. The important branches are:—(1) The inferior labial artery arises below the angle of the mouth and passes into the lower lip deep to the depressor anguli oris. In the lip it penetrates the orbicularis oris and runs to the middle line near the edge of the lip close to

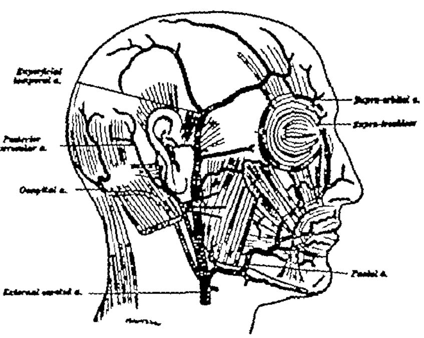


FIG. 17

The arteries of the face and scalp. The facial artery is to be coloured and its branches named. The facial nerve is shown crossing the upper part of the external carotid artery, the parotid gland not being represented.

the mucous membrane (Fig. 13); there it anastomoses with the opposite artery. There is almost constantly another branch of the facial artery in the lower lip which runs medially at a lower level under cover of the depressor labii inferioris. (2) The superior labial artery arises about the level of the angle of the mouth, and, lying between the orbicularis oris and the mucous membrane of the lip near its margin, runs in a tortuous course to the middle line. It freely anastomoses with the vessel of the opposite side and gives off a septal branch which passes up and to the lower and anterior part of the nasal septum; this artery is the source of the troublesome bleeding from ulcers of this part of the septum. (3) The lateral nasal artery passes to the side of the nose.

The **transverse facial artery** (Fig 17) arises from the superficial temporal artery whil it l in the substance of the parotid gland , It emerges from the anterior border of the gland and runs forward across the masseter between the zygoma and the parotid duct It supplies the parotid gland and duct and the surrounding muscles and integument and anastomoses with the angular artery which it occasionally replaces It is accompanied by the zygomatic branches of the facial nerve.

The **anterior facial vein** commences at the medial angle of the eye as the angular vein, which is formed by the union f th supra-orbital and frontal veins from the forehea l; by it tributaries it communicates with the ophthalmic veins of the orbit and through them with the cavernous venous sinu in the skull. It lies behind the facial art ry and f llow it downwards into the neck, but it is a much less tortuous vessel and l more superficial at it upper part; below the angle of the mouth it lies close to the rtery and it often overlaps it as it crosses the lower border of the mandible. Its branches correspond with those of the facial artery and it is joined at the anterior border of the masseter muscle by the **deep facial vein** which connect it to the venous plexus of the infra temporal (pterygoid) space The connexions of the anterior facial vein are important for septic infections of the face may extend along them to the interior of the skull. The vein and its branches do not possess valves.

The **trigeminal** (fifth cranial) **nerve** is the sensory nerve of the face it supplies, for example the conjunctiva the mucous membrane of the nasal cavity the mucous membrane of the mouth the teeth and the skin of the forehead and the face except a strip over the angle of the jaw and in front of the ear which is supplied from the cervical plexus (Fig 18) The nerve is distributed in three divisions, the **ophthalmic** (first) the **maxillary** (second) and the **mandibular** (third) divi ion. Each division supplies a precise area of the face there being but little overlap of neighbouring areas there is however con ideral le variation in the areas of the back part of the face supplied by the second and third divisions. The superficial branches of the nerve are to be examined (Fig. 16) Most of them will have been secured. Those of the **ophthalmic division** are the **supra-orbital, supra-trochlear infra trochlear** and **lacrimal** nerves which perforate the palpebral fascia of the upper lid, and the **external nasal** nerve which emerges on the nose between the nasal bone and the lateral cartilage The **maxillary division** appears as a compact group of **infra-orbital** nerves through the infra orbital foramen. They lie deep to the levator labii superioris which should be completely removed to expose them. There are also two small **zygomatic** branches of this division which are distributed over the malar region. The **mandibular division** is represented by the **mental** nerve which issues through the mental foramen the **auriculo-temporal** nerve which ascends in front of the auricle and the **buccal nerve** which should be sought at the anterior border of the masseter muscle on the surface of the buccinator muscle. These nerves are all accompanied by small blood vessels which bear the same names.

The Development of the Face.—The distribution of the three divisions of the fifth nerve is explained by the development of the face.

The face is formed from five processes which are separate from one another in the early stages of development; they form the boundaries of the stomodæum, the primitive mouth cavity. The processes are the fronto-nasal process, a broad bilateral process which lies above the stomodæum, two maxillary processes which lie at its sides, and two mandibular processes which bound it below; each process carries its own nerve, the three nerves on each side being the ophthalmic, the maxillary and the mandibular division of the fifth nerve.

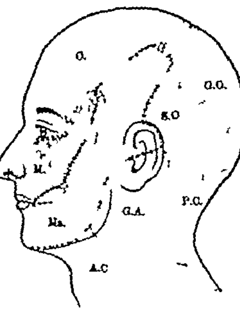


Fig. 18.

The cutaneous nerve areas of the face and scalp.

A.C., anterior cutaneous n. of neck; G.A., great auricular n.; G.O., great occipital n.; M., maxillary n.; Ma., mandibular n.; O., ophthalmic n.; P.C., posterior rami of third and fourth cervical nn.; S.O., small occipital n.

In the fourth week of development the fronto-nasal process becomes divided into three parts by the appearance of two nasal pits. The pits deepen by growing into the substance of the process (Fig. 19); they ultimately form the nasal cavities. *The three parts of the fronto-nasal process are the median nasal process*, which occupies the wide area between the nasal pits, and the two lateral nasal processes, which lie lateral to them. On the lower end of the median nasal process two small rounded swellings, the globular processes, appear; they grow laterally below the nasal pits. The lateral nasal, maxillary and mandibular processes grow centrally towards the middle line. The mandibular processes soon meet and fuse with one another and together form the lower boundary of the stomodæum; from their substance there are derived the lower jaw, *the muscles of mastication and of the floor of the mouth*, ne

lower part of the cheek, and the lower lip, and it is to these parts that the mandibular nerve is distributed. The upper edge of the mandibular process fuses with the lower edge of the maxillary process as far as the angle of the mouth, the position of which—and therefore the final size of the mouth—is determined by the extent of the fusion (Fig. 20). The upper edge of the

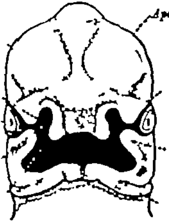


FIG. 19

The face of a human embryo in the fifth week (8 mm. long).

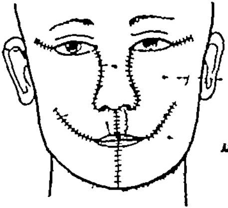


FIG. 20.

The parts of the face formed from the embryonic processes.

maxillary process fuses with the lower edge of the lateral nasal process along a line which in the adult runs from the medial angle of the eye to the lateral border of the ala of the nose; the continuity of the cheek and the side of the nose is thus established. A solid cord of ectoderm develops along the line of fusion; later it becomes canalized, acquires an opening into the lower part of the nasal cavity and forms the naso-lacrimal duct. The apex of the

supplies the conjunctiva at the medial angle of the eye and the skin of both eyelids and the root of the nose The external nasal nerve becomes superficial between the nasal bone and the upper lateral nasal cartilage It descends under cover of the aponeurosis of the compressor naris and supplies the skin of the fore part and vestibule of the nose

Maxillary Division.—The terminal part of the maxillary division is the infra-orbital nerve. It appears through the infra-orbital foramen a a leash of branches which join with the deep buccal branches of the facial nerve to form the infra-orbital plexus; the plexus lies deep to the levator labii superiori Its branches spread upward into the lower eyelid (palpebral branches) where they supply the skin and conjunctiva, over the side of the nose of which they supply the skin (nasal branches), and downwards into the upper lip (labial branches) supplying the skin and mucous membrane of the cheek and lip. The zygomatic nerve arises from the maxillary division before it reaches the floor of the orbit. It courses along the lateral wall of the orbit and divides into two branches, the zygomatico-temporal and the zygomatico-facial, which emerge on the face through foramina in the zygomatic bone; both nerves are small. One nerve passes upwards into the temporal fossa and reaches the skin of the lower part of the temple and the other supplies the skin over the prominence of the cheek.

Mandibular Division.—The buccal nerve enters the cheek from under cover of the masseter muscle and ramifies in the fat over the buccinator muscle joining there the buccal branches of the facial nerve. It supplies the skin and the mucous membrane of the lower part of the cheek. The auriculotemporal nerve becomes superficial by emerging from the upper border of the parotid gland. It then ascends into the temporal region over the root of the zygomatic arch, lying behind the superficial temporal artery and immediately in front of the auricle Its terminal branches supply the skin of th temporal region, and in its course it gives branches to the front of the upper part of the auricle, the front of the external auditory meatus and tympanic membrane the mandibular joint and the parotid gland the glandular branches are secreto-motor and reach the nerve from the glosso-pharyngeal nerve The mental nerve is the terminal part of the inferior dental nerve which lies in a canal in the mandible. It emerges at the mental foramen and deep to the depressor anguli oris divides into branches which supply th skin of the chin and the skin nd mucous membrane of the lower lip. They form a plexus with the mandibular branch of the facial nerve

There are three constant groups of lymph glands in the head the parotid the mastoid, and the occipital glands they lie in the positions shown in Fig I and drain the areas indicated there In addition to them small lymph gland are often to be found on the face they may occur in three places on the upper part of the anterior facial vein (infra-orbital glands) on the buccinator muscle (buccal glands) and on the mandible in front of the masseter muscle (supra mandibular glands)

The lymph vessels of the front part of the face as high as the root of the nose accompany the anterior facial vein and its tributaries and pass to the submental and submandibular glands in the upper part of the neck interposed on them are the small inconstant facial glands. The lymph vessels of the forehead and back part of the face accompany the temporal and transverse facial veins and pass to the parotid glands

These glands lie on and deep to the fascia covering the gland and in its substance: one or more of the superficial glands (pre-auricular glands) may often be felt immediately in front of the tragus of the auricle.

The efferent lymph vessels of the lymph glands of the head all pass to the upper deep cervical glands.

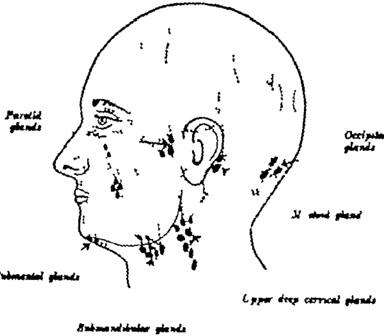


Fig. 21

The superficial lymph glands of the head and neck.

DISSECTION OF THE BACK OF THE NECK AND THE BACK

The body will be turned on to its face on the fourth day after it is brought into the dissecting room and it will remain so turned for six days. The dissectors are first to make **a superficial dissection of the back of the neck,** examine the **external parts of the auditory apparatus,** and dissect the **hinder part of the scalp** and the upper part of the **posterior triangle of the neck.** The dissectors of the arm will by then have removed the superficial muscles of the back, namely the trapezius, latissimus dorsi and rhomboid muscles, and the dissectors of the head and neck will be free to examine the **deep or post-vertebral muscles of the back** including the special arrangement of them in the neck.

Surface Anatomy – The **nuchal groove,** the median furrow on the

back of the neck, is most evident when the head i erect though in fat people it is obliterated even then. It begins below at the knob like projection of the spinous process of the seventh cervical vertebra and it ends above in a depression over the lower part of the occipital bone The **external occipital protuberance** or **inion** lies at the top of the nuchal depression it varies in its size and form but it i always palpable and is easily recognised on X ray photographs (Plate I) It lies below the most posterior part of the skull. The **superior nuchal lines** arch laterally from the inion towards the base of the ma toid processes the superficial muscles of the neck are attached to them, and they mark the boundary between the back of the head and the back of the neck The **lambda** is the meeting place of the sagittal and lambdoid sutures it is two or two and a half inches above the inion and in many skulls the occipital bone is thickened and elevated behind it and there is an irregular depression at it. The **lambdoid suture**, irregular and uneven to the touch runs downwards and forwards on each side from the lambda and the **sagittal suture**, often in a linear groove in old people runs forwards in the middle line.

The **mastoid part of the temporal bone** lies on the side of the head behind the auricle The **mastoid process** is the thick downward process from it to be felt under the skin behind the lower half of the auricle it is small in children, and much smaller in women than in men The **supra-mastoid crest** curves backwards and upwards over the base of the process from the upper margin of the external auditory meatus it can usually be felt in the adult as a slight ridge about an inch long and is continued into the inferior temporal line The **supra-meatal triangle** is the small depression below the anterior end of the crest an l immediately above and behind the auditory meatus. It lies un ler cover of the attachment of the auricle but can be felt through it (p 65) and it may also be recognised if the auricle is pulled forwards and downwards and the finger pressed in behind it. There is a much more distinct depression at the **asterion** which is not to be mistaken for it the asterion is at the junction of the posterior inferior angle of the parietal bone and the mastoid part of the temporal bone and lies well behind the upper part of the auricle (Fig 1)

The **spines of the cervical vertebræ** above the sixth and seventh are felt only indistinctly in the floor of the nuchal groove and, as the atlas has no spine the highest process to be felt is that of the axis it lies about two inches below the inion (see Plate I) The process of the seventh vertebra usually makes a visible projection. The lateral end of the **transverse process of the atlas** lies below the tip of the mastoid process (Plate III) under cover of the anterior edge of the sterno-mastoid muscle and the lower end of the parotid gland, and can usually be felt by deep pressure in the hollow below the auricle. The **transverse processes** of the lower cervical vertebræ are too deeply placed to be felt though the anterior tubercle of the sixth process can often be distinguished at the level of the cricoid cartilage in front of the sterno-mastoid muscle.

Superficial Dissection of the Back of the Neck

Reflection of the Skin. A block is to be placed under the chest to ... be flexed and so open up the area of the neck ... should join the incision ... the vertex of the head to the ... incision is to be ... the thickness of the skin is to be noted. ... of the head to the ear ... the reflection ... onto the side ... the skin is intimately connected to the ... these ... have to be cut ... on the back of the neck the skin is ... The superficial fascia is to be left intact.

The skin ... and is ... than in any other part ... the hair is lost ... superficial fascia. It is ... the follicles of the ... The skin has rich ... on the back of the neck is ... to the fascia. It has a ...

The **superficial fascia** ... contains ... the muscles ... difficult. The ... of the **trapezius**, ... attached to ... of the superior ... and (2) ... **sterno-mastoid muscle**, ... attached to the ... line (Fig. ...) ... the nuchal line ... carefully ... and ...

The **cutaneous nerves of the back of the neck and scalp** are to be ... being defined ... be arranged in ... **posterior primary rami** ... **cervical nerves** ... perforate ... and ... **small occipital** ... **great auricular nerves**, ... of the **cervical plexus**, ... sterno- ... **great occipital nerve**, ... be ... and

lateral to the external occipital protuberance and runs upwards to the scalp. The **occipital artery**, which lies close to the nerve and may serve as a guide to it, is to be dissected out of the superficial fascia of the scalp and traced downwards to its point of emergence from the trapezius muscle (Fig. 22). The **third occipital nerve**, the cutaneous branch of the posterior ramus of the third cervical nerve, will be found between the great occipital nerve and the middle line; it supplies the skin of the back of the neck and the lower part of the scalp. The cutaneous branches of the fourth and fifth posterior rami will be found

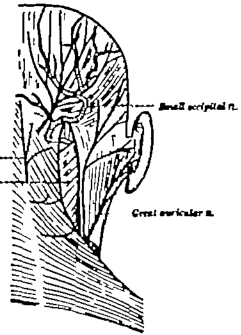


Fig. 22.

Superficial dissection of the back of the neck and scalp. The occipital artery is to be coloured, and the trapezius and sterno-mastoid muscles, the great occipital nerve and the posterior cutaneous branches of the fourth and fifth cervical nerves are to be named.

at a lower level; they pierce the trapezius close to the middle line and run laterally and even a little downwards. When these nerves have been secured the trapezius muscle may be safely cleaned right to its lateral margin. The **great auricular nerve** is usually easily found. It emerges from the posterior border of the sterno-mastoid muscle near the junction of its upper third and lower two-thirds, and ascends across the muscle towards the ear. The **small occipital nerve** will be found a little above and behind the great auricular nerve. It runs upwards along the posterior border of the sterno-mastoid muscle to the scalp where it is distributed on the lateral side of the great occipital nerve (Fig. 22).

The External Ear

When this superficial dissection has been carried out the student is to examine the external ear; that is, the external parts of the organ of hearing. These parts are the auricle and the external auditory meatus: the former projects from the temporal region of the side of the head and the latter leads inwards to the middle ear which is in the substance of the temporal bone.

The auricle or pinna, commonly called the ear, consists of a thin folded plate of yellow fibro-cartilage covered with skin. It is attached by ligaments to the side of the head nearer the back than the front, and is provided with a set of feeble muscles for its movement; these muscles form the auricular group of the facial muscles (p. 25). The

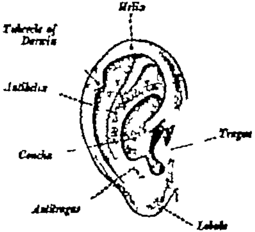


FIG. 23.
The lateral surface of the auricle.

cranial surface of the auricle is in general convex and the lateral surface in general concave; but the cartilage has several secondary folds and these produce the elevations and depressions of its typical form. There are, however, great individual differences in the details of the form; and it is worth noting some forms are physical evidences of mental enfeeblement and some even stigmata of degeneration. The auricle normally becomes larger in old age; this is due to the flattening of its curvature and the loss of its elasticity rather than to its growth.

The lateral surface of the auricle (Fig. 23).—The margin of the auricle, which is rolled on itself in the greater part of its extent, is named the helix. It begins in front in a strong bar, the crus helicis, which cuts into the concha—the deep fossa which occupies the middle of the auricle—and divides it into upper and lower parts. A small tubercle, the auricular tubercle of Darwin

is often present on the helix in men as it turns from the top to the posterior edge of the auricle. It is much more evident in late fœtal life and indicates the point or tip of the auricle; it usually disappears in women. A second tubercle may be present below it; it is a stigma of degeneration. The helix is continued below into the lobule, the soft dependent part in which there is no fibro-cartilage; it varies greatly in its size and in its independence of the cheek. The curved prominence which bounds the concha behind is the **antihelix**; it divides above into two **crura antihelicis**, which enclose a triangular fossa between them, and it ends below in a small projection, the **antitragus**. The prominence which projects in front of the lower part of the concha is the **tragus**; it carries a tuft of hairs, larger and thicker in men after middle age. The hairs grow backwards and protect the external auditory meatus into which this part of the concha leads. The notch between the tragus and the antitragus is the **incisura intertragica**. The student is to palpate the surface of the skull through the upper part of the concha of his own ear, working with his finger above the crus helicis; he will be able to recognise the supra-meatal triangle as a depression and the supra-meatal crest as a ridge above it.

The student is to display, without further dissection of them, the three **extrinsic muscles of the auricle**, the superficial fascia being removed in the positions indicated by their names; the muscles are the **auriculares anterior, superior** and **posterior**. The anterior and superior muscles arise from the epicranial aponeurosis and the posterior muscle from the mastoid process, and they are inserted into the cartilage of the auricle. These muscles represent the more complex musculature of lower mammals by which the auricle is moved, but in man they can rarely be used voluntarily; and with the **occipitalis**, which properly belongs to them though it has lost its attachment to the auricle, they form the auricular group of the facial musculature (p. 25) and are supplied by the facial nerve. The anterior and superior muscles are supplied by the temporal branches of the facial nerve and the posterior muscle and the occipitalis by the posterior auricular branch. The **posterior auricular nerve** and the accompanying **posterior auricular artery** are to be secured in the groove between the auricular cartilage and the mastoid process; the artery passes deep to the posterior auricular muscle.

The skin is now to be removed from at least part of the auricle to display the **auricular cartilage**. It extends throughout the auricle with the exception of the lobule and its foldings give it its shape; and in addition it forms the cartilaginous part of the external auditory meatus. Attached to the cartilage there are several small **intrinsic auricular muscles**, also supplied by the facial nerve, and the **auricular ligaments** which fix it in position, but no attempt need be made to define them.

The skin of the auricle is thin. It carries fine hairs provided with sebaceous glands; the glands are largest and most numerous in the concha. It is closely adherent to the cartilage, especially on the lateral surface, there being very little subcutaneous tissue; subcutaneous exudates are thus restricted in their spread and their tenseness makes them painful. There is practically no fat in the subcutaneous tissue so that the blood vessels which lie in it are

ill protected from cold. The cartilage is immediately covered with a thick vascular perichondrium; hæmorrhage from its blood vessels is easily caused by injury

The **mastoid lymph glands**, two or three small glands, lie on the mastoid insertion of the sterno-mastoid muscle deep to the auricularis posterior; this muscle is to be reflected and they are to be sought. They drain the posterior part of the *temporo-parietal region of the scalp*, the pper part of the cranial surface of the auricle and the back of the external auditory meatus (Fig. 21) The **occipital lymph glands** are more difficult t discover; they lie on the trapezius close to its occipital origin or on the back of the head between it and the sterno-mastoid. They drain the lymph from the occipital region of the scalp (Fig 21).

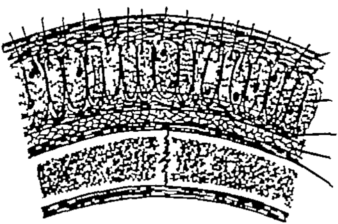


FIG. 24.
A diagram of the scalp and cranial bones in section.
The pericranium is to be coloured.

The Scalp

The student is now to make an examination of the structure of the **scalp**, that is, of the soft tissues which cover the vault of the skull (Fig 21) There are five layers to be considered namely (1) the **skin** (2) the **superficial fascia** (3) the **epicranial aponeurosis** (4) a layer of loose **areolar tissue** below the aponeurosis and (5) the **pericranium**, which is the periosteum of the external surface of the cranial bones. The skin, superficial fascia, and epicranial aponeurosis are intimately united nd together form a movable layer over the bones and this layer is stretched with such tautness over the skull that blows with a blunt instrument may produce wounds that appear to have been incised with a knife

The skin of the scalp been removed it is described on p. 52.

The **superficial fascia** is a dense network f tough inelastic fibrous tissue in whose meshes small shot like masses of fat are enclosed it

is less thick and less dense over the forehead and on the sides of the head The main bundles of the fibrous tissue run vertically and obliquely between the skin and the epicranial aponeurosis and are firmly attached to them the three layers are thu intimately bound together as occurs also in the palm of the hand and the sole of the foot where the superficial fascia has a similar structure. The density of the fascia prevents the spreading of subcutaneous hæmorrhage and inflammatory exudates in it. The main trunks of the **cutaneous nerves** and the **blood vessels of the scalp** lie in the fascia and are now to be examined.

The **cutaneous nerves of the scalp** in front of a line drawn between the auricles have already been found to be derived from the three divisions of the trigeminal nerve they are the **supra-orbital, supra trochlear, zygomatic, and auriculo-temporal nerves** (Fig 16) The nerves which are di tributed to the scalp behind the auricles are branches of the cervical spinal nerves. They are from the middle line forwards to the auricle the **third occipital, great occipital, small occipital, and great auricular nerves** (Fig 22) They have already been secured and are now to be followed out to their distribution.

The **third occipital nerve** is the medial branch of the posterior primary ramus of the third cervical nerve It pierces the trapezius muscle lose to th middle line of the neck, and running upwards on the medial side of the great occipital nerve it communicates with it and distributes branches to the upper part of the neck and the lower part of the scalp.

The **great occipital nerve** is the chief cutaneous nerve of the posterior part of the scalp It is the medial branch of the posterior primary ramus of the second cervical nerve and becomes superficial by piercing the occipital origin of the trapezius m scle. It passes upward and laterally in the superficial fascia of the scalp and breaks into a number of branches which radiate over the back of the head; they are distributed to the kin as far forwards as the vertex of the head They are accompanied by branches of the occipital artery

The **small occipital nerve** is a branch of the cervical plexus. It is variable in size It emerges from under the sterno-mastoid muscle nd runs upwards along its posterior border beneath the deep fascia (Fig 22) It enters the superficial fascia over the upper end of the muscle and supplies the lateral occipital and the mastoid regions f the scalp and the cranial surface of the upper part of the auricle. It communicates with the great occipital and great uricular nerves.

The **great auricular nerve** is the largest cutaneous branch of the cervical plexus. It wind round the posterior border of the sterno-mastoid m scle and, having pierced the deep fascia, courses vertically upwards over the muscle towards th angle of the lower jaw in company with the external jugular vein (Fig. 25). It divides there into branches which are distributed to the skin over the mastoid process, both surfaces of the lower part of the auri le the cheek over the parotid gland, and th angle of the jaw (Fig. 18).

The **arteries** which are distributed to the scalp are large tortuous vessels (Fig 17) They enter the scalp at its margins and lying in the superficial fascia in which they ramify are directed towards the vertex of the head. They anastomose freely with one another and across the middle line with the vessels of the opposite side. On account of their

arrangement large flaps of the scalp may be turned downwards from the vertex towards the margins of the head and if they remain attached there do not undergo necrosis since their blood supply is intact and if they are replaced healing readily occurs. The walls of the arteries are intimately connected to the fibrous septa of the fascia. They are thus held open when they are cut and bleeding is profuse and the attachment to the fascia makes them difficult to catch and ligature through a scalp wound. The **occipital artery** supplies the back part of the scalp the **posterior auricular artery** ascends behind the auricle, and the **superficial temporal artery** in front of it these vessels are branches of the external carotid artery The anterior part of the scalp is supplied by the **supra-orbital** and **supra-trochlear arteries** which accompany the supra-orbital and supra trochlear nerves these vessels are branches of the ophthalmic artery itself a branch of the internal carotid artery All the trunks have already been secured they should now be traced to their distribution (Fig 17)

The student is to revise the general description of the carotid arteries and the jugular veins on p. 15 (Figs. 7 and 8)

The occipital artery arises in the front of the neck from the external carotid artery and passes backward under cover of the sterno-mastoid muscle Near its termination it emerges in the interval between the sterno-mastoid and trapezius muscles, or pierces the trapezius close to the occipital bone and enters the superficial fascia of the scalp on the lateral side of the great occipital nerve It divides there into medial and lateral branches which supply the occipital and posterior parietal regions of the head; they are tortuous vessels and difficult to isolate from the fascia. They anastomose freely with one another and with the branches of the opposite vessel and the posterior auricular and superficial temporal arteries. The medial branch often gives off a meningeal twig which enters the skull through the parietal foramen and anastomoses with the middle meningeal artery

The posterior auricular artery (Fig 17) is a smaller branch of the external carotid artery and arises in the front of the neck. It reaches the groove between the mastoid process and the auricle and there divides into branches which supply the auricle and the scalp over the insertion of the sterno-mastoid muscle The auricular branch ascends under cover of the auricularis posterior; it supplies both surfaces of the auricle. The scalp branch passes backwards over the surface of the mastoid process Both branches are accompanied by the terminal twigs of the posterior auricular branch of the facial nerve

The superficial temporal artery (Fig. 17) is also a branch of the external carotid artery It emerges from the upper border of the parotid gland and, having pierced the deep fascia, crosses the zygomatic arch in front of the ear and enters the superficial fascia of the scalp. It divides there about one inch above the zygoma, into frontal and parietal branches which ascend towards the vertex of the head accompanied by the temporal branches of the facial nerve and the branches of the auriculo temporal nerve. The branches anastomose with one another and with the vessels in front of and behind them They are tortuous arteries and their tortuosity increases with age and with the disappearance of the fat of the temporal region, as occurs with age they are seen beneath the skin. The transverse facial artery which was dissected

on the face arises from the temporal artery while it is still in the substance of the parotid gland, and there are now to be secured the f llowing further branches (Fig 17): (1) Auricular branches to the lateral surface of the auricle (2) The zygomatic artery which runs along the upper border of the zygomatic arch between the two layers of the temporal fascia to the lateral angle of the orbit. (3) The middle temporal artery which arises above the zygoma and perforates the temporal fascia. It ends in the temporal muscle and anastomoses with the deep temporal arteries.

The supra-orbital and supra-trochlear arteries (Fig 17) are branches of the ophthalmic artery which arises from the internal carotid artery in the cranial cavity They leave the orbit within which they arise by winding round the supra-orbital margin with the nerves which they accompany; nd ascending over the forehead they anastomose with one another and with the temporal artery and supply branches to the upper eyelid and the skin, muscles and pericranium of the forehead.

The veins of the scalp form a freely ana tomosing network in the superficial fascia over the whole area of the scalp the veins are valveless and their walls are adherent to the fibrous septa of the fascia. The network is drained in two ways namely (1) by a series of trunks which follow more or less closely the course of the arteries of the scalp each main artery being accompanied by a single vein and not by venæ comites and (2) by a series of emissary veins which pass through the skull bones and end either in the diploic veins in the substance of the bones or directly in the intra-cranial venous sinuses. The emissary veins are one means of the spread of extra-cranial infection to the bones of the skull and the meninges of the brain they also allow a disgorgement of the intra-cranial blood to the veins of the scalp

Th occipital vein issues from the occipital venous network and, lying superficial to it, accompanies the occipital artery into the sub-occipital region; it ends there in a plexu of veins which will be dissected later The posterior auricular vein is much larger than the corresponding artery and lies posterior to it It leaves the artery at the base of the scalp and passes downwards and forwards over the mastoid process and the upper end of the sterno-mastoid muscle and, near the angle of the j w terminates in the external jugular vein (Fig 8) The superficial temporal vein is formed above the zygomatic arch by anterior and posterior tributaries from a wide area of the scalp network and is joined there by the middle temporal vein which arises from a plexus beneath the temporal fascia. It then crosses the ygomatic arch in company with the superficial temporal artery and, having pierced the covering fascia, enters the substance of the parotid gland; it ends there in the posterior facial vein (Fig. 8). The supra-orbital vein is a large trunk which commences on the lateral side of the orbit and runs transversely above the supra-orbital margin. It lies beneath the orbicularis oculi but pierces the muscle near the medial angle of the eye and joins the supra trochlear vein to form the angular vein. The supra-trochlear vein descends in the forehead immediately beneath the skin It lies near the middle line and has frequent anastomoses by cross branches with the opposite vein; one such branch lies on the root of the nose and receives the dorsal nasal veins from below The vein terminates by joining the supra-orbital vein t form the angular ein.

The **emissary veins** are the veins which connect the extra-cranial veins with the diploic veins and the intra-cranial venous sinuses; they are valveless veins and the blood flow in them may be in either direction. They are extremely numerous and not only pass through all the foramina of the skull and the sutures between the bones but penetrate all parts of the surface of the bones; it is customary however to restrict the name to some of the larger connecting channels. Those within the present dissection are: The **mastoid vein** passes through the mastoid foramen and connects the occipital or posterior auricular vein with the lateral sinus. It is sometimes extremely large. The **parietal vein**, variable in size, traverses the parietal foramen and joins the venous network of the scalp to the superior sagittal sinus. The **supra-orbital vein** sends a large branch through the supra-orbital notch to join the superior ophthalmic vein, which itself empties into the cavernous venous sinus; as it traverses the notch the branch is joined by one of the frontal diploic veins.

The **occipitalis muscle** is to be cleaned by removing the superficial fascia that covers it. It arises as a broad thin sheet from the lateral two-thirds of the superior nuchal line of the occipital bone, and after a short course of about an inch upwards and forwards its fibres end in the epicranial aponeurosis. The superficial fascia is then to be removed to expose a large area of the **epicranial aponeurosis**, the extent and connexions of which are to be examined. This is to be done by making a long median incision in the aponeurosis and passing the handle of a scalpel under it anteriorly and posteriorly and from side to side. It will thus be demonstrated that the **third layer of the scalp** is a musculo-aponeurotic sheet which covers the top and sides of the skull from the occipital region to the root of the nose that the muscular bellies are the occipitales behind and the frontales in front and that the epicranial aponeurosis is the intermediate tendon between the muscles.

The **epicranial aponeurosis** is a thin strong tendinous sheet between the frontal and occipital muscles. It is prolonged between the frontal muscles until their medial edges meet and between the occipital muscles to gain attachment to the external occipital protuberance and the medial parts of the superior nuchal lines. It gradually becomes thinner on the sides of the skull and as a fascial rather than a tendinous structure descends for some distance over the temporal fascia; it gives place to the muscles of the auricle. It is closely connected to the skin by the superficial fascia, the fibrous processes of which can be separated from it only with the cutting edge of a scalpel; the area that it underlies is that which commonly becomes bald in men. Its deep surface is so loosely attached to the underlying pericranium by the layer of areolar tissue (the fourth layer of the scalp) that it glides freely over the vault of the skull, and it may so be moved by the alternate contraction of the frontal and occipital muscles; as it moves it necessarily carries the skin with it. The looseness of the attachment allows large flaps of the scalp to be torn off by accident.

The **fourth layer of the scalp** is formed by the layer of loose **areolar tissue**. It will be seen, if a strip of the epicranial aponeurosis is raised

to be of fine texture and to form a feeble connexion between the aponeurosis and the underlying pericranium It becomes much more dense, however below the temporal ridges on the sides of the skull and over the supra-orbital regions in front and it is on this account that while effusions beneath the aponeurosis may raise the scalp from the greater part of the calvarium they do not tend to spread into the temporal regions or far onto the face. Such effusions further would not spread posteriorly beyond the superior nuchal lines owing to the attachment of the occipital muscles and the epicranial aponeurosis to them The areolar tissue contains a few minute arteries branches of the arteries of the scalp proceeding to the pericranium and is traversed by the emissary veins the vein may readily carry infections of the sub-aponeurotic space to the skull bones and the interior of the skull.

A large area of the epicranial aponeurosis is to be removed to expose the **pericranium**, that is the periosteum on the exterior of the vault of the skull which constitutes the **fifth layer of the scalp.** It is a strong thin layer of fibrous tissue which is readily separated from the bones it covers though it is more adherent in the temporal fossa It is reflected through the foramina of the skull and through the sutures as long as they remain open and becomes continuous with the periosteum on the inner surface of the bones that i with the outer (periosteal) layer of the dura mater Extravasation of blood under it therefore do not transgress the sutures of the bones over which they occur The pericranium does not contribute much to the blood supply of the skull bones in the adult it can be removed therefore even from a considerable part of the skull vault without producing necrosis of the bones. In the child it is a thicker and more vascular membrane and hæmorrhage between it and the bones more readily occurs.

The Posterior Triangle of the Neck

The student is now to carry out a superficial dissection of the **posterior triangle of the neck.**

The side of the neck is considered to extend from the middle line in front to the anterior border of the trapezius muscle behind and to be limited below by the clavicle and above by the lower border of the mandible, the mastoid process and the superior nuchal line of the occipital bone It is divided for purposes of description into anterior and posterior parts, the **anterior and posterior triangles of the neck,** by the sterno-mastoid muscle, which descends from the mastoid process and the superior nuchal line to the sternal end of the clavicle and the anterior surface of the manubrium sterni (Fig 25)

The **posterior triangle** is thus bounded in front by the posterior border of the sterno-mastoid muscle and behind by the anterior border of the trapezius (Fig. 4) while its base is formed by the clavicle between the attachments of these muscles. The apex of the triangle is at the superior nuchal line of the occipital bone and here the cranial attachments of the trapezius and sterno-mastoid muscles may or may

not meet one anoth r if they do not meet there is a fibro-tendinous arch between them. The triangle is covered by a layer of **deep cervical fascia**, not very strong and therefore difficult to display as an entire sheet. It is continuous with the fascia investing the bounding muscles in front and behind (Fig. 4) It is attached below to the clavicle. It and the thin superficial fascia covering it are to be gradually removed and the boundaries of the triangle cleanly defined and while doing so the following structures are to be secured and cleaned as far as is directed below

(1) The lower part of the triangle is covered by the postero-inferior part of the **platysma muscle** which lies in the superficial fascia. It is a

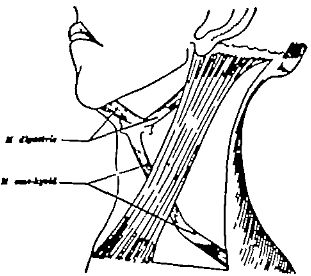


FIG. 25.
A diagram of the triangles of the neck. The student is to colour and name the triangles.

thin sheet of muscle formed f pale fibres which arise below the clavicle and are directed upwards and forwards. It is to be very carefully divided from behind forwards along a line above the clavicle and turned forwards deep to it there is a considerable amount of loose cellular tissue which is the deep fascia.

(2) The **external jugular vein** lies in the superficial fascia. It commences near the angle of the jaw at the lower end of the parotid gland, being formed there by the junction of the posterior branch of the posterior facial vein and the posterior auricular vein (Fig 8), and passes vertically downwards across the sterno-mastoid muscle. It enters the posterior triangle at its lower anterior corner embedded in the cellular tissue beneath the platysma muscle, and, continuing its

course is lost to view behind the clavicle (Fig ( ) At the posterior border of the sterno-ma t id muscle it u ually receives the **posterior external jugular vein** which descends along that border of the muscle from the sub-occipital region

(3) The **cutaneous branches of the cervical plexus** enter the posterior triangle from under the posterior border of the sterno-mastoid muscle (Fig 26) They may be grouped in three set (a) Ascending branches the **great auricular and small occipital nerves** which have already been secured and traced to their distribution on the face the auricle and

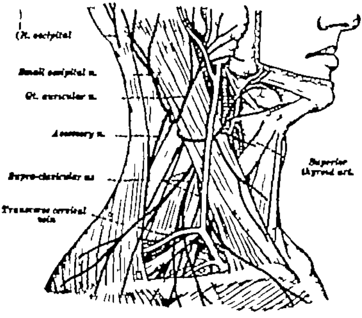


FIG 26.

Superficial dissection of the side of the neck. The posterior urlcular and external jugular veins and the posterior belly of the omo-hyoid muscle are t be coloured, and the anterior cutaneous nerve of the neck is t be named.

the scalp (b) a transverse branch, the **anterior cutaneous nerve of the neck** which emerges a little below the great auricular nerve and runs transversely across the sterno-mastoid muscle It i to be followed only to the point where it crosses either superficial or deep to the external jugular vein and (c) descending branches the **supra-clavicular nerves**, which run downwards for some distance under the deep fascia and piercing it, cross the clavicle beneath the platysma in three groups, anterior middle and posterior in position. The main trunks of these nerves are to be secured at present, but no attempt is to be made to follow them out in detail.

(4) While the external jugular vein is being defined and the cervical cutaneous nerves are being secured the dissector will encounter a number of small **lymph glands** in the superficial fascia close to the upper part of the vein and also a strip of **areolo-lymphoid tissue** along the posterior border of the sterno-mastoid muscle. The glands are the **superficial cervical glands** they drain the parotid region and the lower part of the auricle and their efferent vessels join the upper deep cervical glands which lie deep to the upper part of the sterno-mastoid muscle. There is also a strip of fatty areolo-lymphoid tissue along and under the anterior border of the trapezius muscle it is possible that it corresponds to the "hibernating gland" of hibernating mammals.

(5) The **accessory** (eleventh cranial) **nerve** emerges at the junction of the upper third and lower two-thirds of the posterior border of the sterno-mastoid muscle in close relation with the small occipital nerve. It runs downwards and backwards across the floor of the posterior triangle and disappears under the anterior border of the trapezius at the junction of its upper two-thirds and lower third (Fig. 26). As it crosses the triangle it is joined by branches from the third and fourth cervical nerves.

(6) The **posterior belly of the omo-hyoid** muscle is to be defined as it crosses the lower part of the triangle (Fig 26) It enters the triangle at its lower and posterior corner and runs upwards and forwards, only a short distance above the clavicle, to the posterior border of the sterno-mastoid muscle under which it disappears. It is in no way to be disturbed in position at the present time. It is customary to divide the posterior triangle into two parts which lie above and below the omo-hyoid muscle. The upper and by far the larger part is named the **occipital triangle** and that below the muscle is called the **subclavian triangle** (Fig 25)

It is in the occipital triangle alone that all further dissection is to be carried out while the body lies on its face, for the subclavian triangle is more easily dissected and the relations of its parts are more easily understood when it is dissected from the front.

The student should, therefore, revise the boundaries of the **occipital triangle** (Fig 25). They are the posterior border of the sterno-mastoid in front, the anterior border of the trapezius behind, and the posterior belly of the omo-hyoid muscle below and in it there have been exposed the superficial branches of the cervical plexus, the accessory nerve, and at its apex, the occipital artery There are now to be found, between the accessory nerve above and the omo-hyoid muscle below the following further contents —

(1) The **transverse cervical artery** which appears from under the upper border of the omo-hyoid muscle and runs backwards across the floor of the triangle (Fig 26)

(2) The uppermost part of the **brachial plexus**, which lies in the angle between the omo-hyoid and sterno-mastoid muscles (Fig 26). It is on no account to be dissected at the present time.

The contents of the occipital triangle having been defined, the

muscles which form its floor are to be recognised and named on Fig 26 These muscles are from above downwards, the **splenius** (a post vertebral muscle) the **levator scapulæ** and the **scalenus medius** they are covered by a layer of deep cervical fascia (Fig 4) through which they are seen to run parallel to one another and to have a general direction downwards and backwards. At the apex of the triangle a small part of another muscle the **semispinalis capitis**, is usually to be seen it is readily recognised since its fibres run vertically

Deep Dissection of the Back

The dissectors of the arm by this time will have exposed and cleaned the **trapezius muscle**, and since though properly a muscle of the shoulder girdle it enters the present dissection and takes part in the movements of the head the dissectors of the head and neck should study again its attachments and relations

The **trapezius muscle** is a triangular muscle, it fibres converging towards a confined insertion from a long median linear origin It arises (in the region of the head and neck) from the external occipital protuberance and the medial third of the superior nuchal line of the occipital bone and from the ligamentum nuchæ and the seventh cervical pinous process; and (within the confines of the dissection of the arm) from the spinous processes of all the thoracic vertebræ and the supra-spinous ligament between them. Its upper fibres are inserted into the lateral third of the posterior border of the clavicle, encroaching also on its upper surface; its middle fibres run more or less transversely to be ttached to the medial edge of the acromion process; and its lower fibres ascend with an increasing obliquity to be inserted into the upper border of the spine of the scapula as far medially as it root. The lowest part of the muscle is inserted by a tendon which glides over the triangle at the medial end of the spine being separated from it by a layer of loose connective tissue and sometimes by a bursa; at the medial end of its insertion the tendon extends from the upper to the lower border of the spine and is recurved laterally on itself like a hook. It is to be noted that a semi-oval tendinous aponeurosis is present in the origin of the muscle opposite the last cervical and upper three or four thoracic vertebræ, that is, in the transverse middle part of the muscle; apart from this region the origin is by short tendinous fibres.

In conjunction with the dissectors of the arm the trapezius muscle is to be divided by a vertical incision about one inch from the spines of the vertebræ, and having separated it from the occipital bone, it is to be thrown laterally On its deep surface there are to be secured and cleaned the **superficial cervical artery** and the nerves which supply it the nerves are the **accessory nerve** and two or three **branches of the cervical plexus** all of which join with one another and form a plexus on the deep surface of the muscle.

The **superficial cervical artery** is one of the two terminal branches of the transverse cervical artery (p. 64), the division of which takes place at the

anterior border of the levator scapulæ muscle; the other branch is the descending scapular artery. The superficial cervical artery crosses the levator scapulæ muscle and is distributed on the under surface of the upper part of the trapezius. (In a considerable number of subjects this artery is a direct branch of the thyro-cervical trunk, and the descending scapular artery then arises independently from the third part of the subclavian artery (p. 115).

The part of the accessory nerve which supplies the trapezius consists of fibres which arise from the cervical part of the spinal cord (see p. 13). The nerve enters the posterior triangle of the neck from under the posterior border of the sterno-mastoid muscle at about the junction of its upper third and lower two-thirds, and at this point the small occipital nerve hooks round it from below (Fig. 26). It runs downwards and backwards across the triangle along the line of the levator scapulæ muscle, being separated from it by its fascial covering (Fig. 6). In this part of its course it is comparatively superficial, being covered only by the skin, superficial fascia, superficial cervical lymph glands, and the deep fascia. Sometimes a few lymph glands lie close beside it; these belong to the deep cervical group. The nerve is joined here by twigs from the third and fourth cervical nerves. It disappears under the anterior border of the trapezius muscle and on its deep surface breaks into branches which join with further branches from the third and fourth cervical nerves to form the sub-trapezial plexus; from this plexus the trapezius receives its innervation.

At this stage of the dissection the attachments of the **levator scapulæ** should be defined for the benefit of the dissectors of the arm, and passing deep to it from its anterior border there are to be secured for them the **descending scapular** branch of the transverse cervical artery and the **nerve to the rhomboid muscles** from the uppermost part of the brachial plexus. The **nerves to the levator scapulæ** should also be secured: they are two small branches from the third and fourth cervical nerves and enter the muscle opposite the middle of the sterno-mastoid muscle.

The **levator scapulæ** arises by four tendinous slips from the posterior surface of the transverse process of the atlas and the posterior tubercles of the transverse processes of the next three cervical vertebræ. The first and second slips are the strongest. The four slips merge into an elongated fleshy muscle which descends in the floor of the posterior triangle of the neck (Fig. 4) and is inserted on the vertebral border of the scapula opposite the supra-spinous fossa. It is essentially a muscle of the shoulder girdle.

The dissectors of the arm will complete their study of the muscles of the second layer of the back, namely the **levator scapulæ** and the rhomboid minor and major muscles, by dividing them and turning them towards their scapular attachments. The dissectors of the thorax and abdomen will then associate themselves with the dissectors of the head and neck in an examination of the **superior and inferior posterior serratus muscles** and after these are reflected, they will study the lumbar fascia together.

The **posterior serrati** belong to the thoracic wall; they are innervated by the anterior primary rami of the thoracic nerves. They are thin sheets,

largely tendinous in their structure being but the remnants of an originally much more extensive sheet and lie one on the upper and one on the lower part of the posterior thoracic wall The superior muscle arises by a broad aponeurosis from the lower part of the ligamentum nuchæ the seventh cervical spine and the spines of the upper two or three thoracic vert bræ and run downwards and laterally to be inserted by fleshy slips into the four ribs below the first lateral to their angles. It is covered by the rhomboids and the trapezius. The inferior muscle is broader and stronger than the superior muscle. It arises from the spines of the lower t thoracic and upper two lumbar vertebræ by an aponeurosis which is fused with the aponeurosis of the latissimus dorsi which covers it, and runs upwards and laterally to be inserted by fleshy slips into the lower four ribs. *The serrati take part in the* movements of the ribs; the upper muscle assists the elevation of the upper ribs, and the lower muscle assists in the fixation of the lower ribs which is necessary for the inspiratory action of the diaphragm

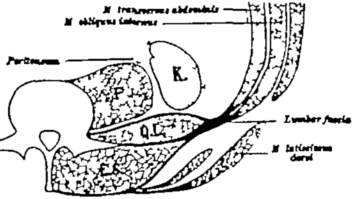


FIG 47

The arrangement of the lumbar fascia in transverse section (diagrammatic).

K., kidney; P psoas muscle; Q.L., quadratus lumborum; E.S., sacro- pinalis. The serratus posterior inferior is deep to the latissimus dorsi.

The posterior serratus muscles are to be carefully isolated from the underlying structures with the handle of a knife and divided close to their origin they are then to be turned laterally and the fine plexuses of nerves, derived from the intercostal nerves by which they are supplied are to be sought on the deep surface of their muscular parts. The greater part of the proper or post vertebral *muscles of the back* (p 9) will now be exposed though below in the lumbar region they are covered by the lumbar fascia

The muscles of the back as the student is now aware, consist of three distinct sets. (1) There is a superficial set consisting of broad flat muscles attached to the skeleton of the fore limb and properly belonging to the limb musculature they have reached their dorsal position by a *migration from the* ventral parts of the trunk. They are supplied by branches from the cervical and brachial plexuses. (2) A middle posterior serratus sheet lies on the superficial surface of

the tho ax and belongs t the th ra ic musculature the sheet is represented only by it upper and lower part the upper and lower posterio serrat These muscles are upplied by the intercostal nerves. (3) The proper **spinal** or **post vertebral muscles of the back** are the deepest set They ar elongated muscles which extend along the whole length f the axial skeleton and are attached to its back parts, nam ly th v rtebral olumn the ribs and the skull They are supplied by th **posterior primary rami of the spinal nerves.** They lie under v r f th wn proper f scia in the neck and thorax this is a thin lay named th **vertebral fascia**, but in the lumbar and sacral regions it i thi k nd I nse and i named the **lumbar fascia.**

The **vertebral fascia** a thin membranous layer which stretches transversely fr the spine and pra spinous ligament of the thoracic ertebræ to the ngles of the ribs some stronger superficial bundles in it probably represent th suppressed intermediat part of the posterior serratus sheet. Above it passe deep t the serratus posterior superior and is continued into the neck lel t la er which co ers the post vert bral muscles of the neck and f se lat rally th the proper rvical fascia (Fig 4) Below it blends with the pone rosi of the serratus posterior inferior and through it is continuous th the uperficial la er of the lumbar f scia

Th **lumbar fascia** co nsist of two layers which enclose between th th lu b a part f the post v rtebral muscles and with the t l f m n osseo-fibr u mpartment w thin which they are t use l (F g) the firm support gi en to the muscles aids them n the ontr ti n *Th superficial lay forms the strong dense* p n u t ring f th muscles ble led with it are the aponeuroses f th l t s u l rs n l serr tu post ri r inf rior which contribute t it tr n th It nt nu m b through the serratus muscle th th rt l l f scia nd l b w at i tta hed t the iliac crest l ll t at hed t the t ps f th pines f the lumbar vertebræ, th t j l g e t n l the l rsum f the sacrum A vertical i t l n l m it fr m bel w th last rib t the iliac crest l ut tw n l t th lu b r p nd t be ng ra sed, the muscle m f t l t l nd th th deep la er f the fascia w ll be p se l Th l l ng in f nt f the post rt bral muscles pa se t th p f th t s pr esse f the lumba vertebræ n i s ul l l l l l t s tt hed t the la t rib nd the l est Th t l f th l scia fuse w th one nother at th l t th l f th l r l u le n l f r l nse apon urosis wh h a t th j l p t f th t rnal l l qu muscle of th l l n l ll Th l l t l l xied k ng tud nally at t junct on th th p t l l f th la t l t the iliac re t l l r th s l t d th l h l ne the f bre of the **quadratus lumborum muscle** w ll t p se l th s run l ng tu l nally f th l l est r th l t l Th l pa t of th lat l l r the f th n u le lies l ut l l n l th t of th p st rt bral n uscles (F g) t upp p t nl l t t It t be l f ned,

and the muscle is to be pushed medially to expose the layer of fascia which covers its anterior surface. This layer which will be dissected with the muscles of the posterior abdominal wall by the dissectors of the abdomen is attached medially to the anterior surface of the roots of the transverse processes of the lumbar vertebræ. Laterally it blends with the fused layers of the lumbar fascia and gives origin to the transversus abdominis muscle. The dissectors of the thorax and abdomen will divide it to expose the infra-costal part of the kidney on its anterior surface (Vol. II). This third layer of fascia properly the fascia of the quadratus lumborum, is often described as the anterior layer of the lumbar fascia and topographically it may well so be considered; the lumbar fascia is then said to consist of posterior, middle and anterior layers.

The **post-vertebral muscles** are to be fully exposed by removing the covering fascia; in the lumbar region it will be found that they arise from its deep surface. The muscles form an elongated mass which fills the groove at the side of the spinous processes and behind the transverse processes on the back of the vertebral column and gives the back its flatness. The mass extends from the sacrum to the occipital bone. In the sacral and lumbar regions it is undivided; in the thoracic region a number of specially named parts of it are described but they represent the segregation of systems of fibres in a complex whole rather than individual muscles, though each system has its own special attachments; in the neck, however, associated with the free movements of the head to which they are attached, the systems of fibres are individualised and there are separate muscles as are found in other parts of the body.

The chief systems of fibres and the muscles which are individualised from them are: (1) A system of longitudinal fibres arising in the main from the lower spinous processes and inserted above into the ribs and transverse processes; the muscles of this system are the **sacro-spinalis**, its secondary parts in the thorax and the neck are the **ilio-costalis** and the **longissimus**, and in the neck the **splenius**. These muscles are supplied by the lateral branches of the posterior primary rami of the spinal nerves. (2) A system of longitudinal fibres attached at both ends to the spinous processes. The muscles of this system are the **spinalis** and the **inter-spinales**; they are supplied by the medial branches of the posterior primary rami of the spinal nerves. (3) A system of oblique fibres arising from transverse processes and inserted above into spinous processes. The muscles of this system are the **semispinalis**, the **multifidus spinæ**, and the **rotatores spinæ**; they are also supplied by the medial branches of the posterior primary rami of the spinal nerves. (4) A system of short longitudinal fibres attached to the transverse processes of successive vertebræ; the muscles are the **inter-transversales**.

The fibres of each system diminish in length from the surface inwards; the superficial fibres are the longest and extend for considerable distances between their attachments, but the deepest fibres may only extend between adjoining vertebræ. All the systems are continued

t the head and as was stated the parts of them attached to it are fully dif rentiated and separate mus les

The nus les f e h system are t be dissected separately but it is not xpected that th student will memorise the details of the origin and nserti n of h muscle he hould understand however their grou f rmations nd th a ti n they have on the vertebral column nd the head

(1) Th **sacro-spinalis system** f muscles sometimes named the er t r spinæ s t m begin a th bulky muscle mass that fills the lumba pa t f the rt l l groove At about the level of the last ri the ma d l nt tw olumn a maller lateral **ilio-costalis** lu un which xt nd f th neck and a larger medial **longissimus** lu n wh h r hes an l ttached t the head There is, further in the ba k larg flat u cle th **splenius**, whi h represents a specialised supert al pr longat n f th s t m to the upper cervical vertebræ nd the he d

The **splenius** i to be tu ied first ts urface is to be cleaned and it ttach n nt dem n trated

The **splenius** *muscle* arise f om the lower half of the ligamentum nuchæ and from the pinous processes f the se enth cervical and the upper six thor l bræ nd the supra pinous ligaments bet een them It runs p rd and later ll bend ng kown the part beneath t like strap, and d ide int t pa t amed n account f their insertion, **plenius capitis** l pl er The **splenius capitis** pass under cover of the sterno-ma t id muscl (Fig 71) nd is ttached t the mastoid process of the t p ral b ne nd the l teral part of the perior nuchal line of the occipital l Th **splenius cervicis** much the malle part of the muscle is inserted l t id n l pr t tl posterior part of the transverse processes of the u t h er l ert bræ behind the slips of origin of the levator sc pul

Th pl l t be s t ered lose t t rigin and turned u l l l l tl thi l pst l ne e which pierces the usc l h l l ut the p t ser pstal nerv wh ch emerges l at u pe l l t be p served. The l v n of the muscle rt it t t be sl seen and the attachment of the rv l l ps l l t th rig n f the le t r scapulæ can be le t r l Th t l t f tl t rn ma t id muscle to the ui n l l l t tl p l l n t be di led n order more f ll t p se th rt n f tl ral part A the splenius is l p red t l t l k n t t nju th **longissimus capitis** **muscle** rt ll u l k t p hi h u ually dh nt to its de p su f

The **sacro-spinalis** l t tw lu m f t on s are now t l na n l

The **sacro-spinalis** l ring ter linous heet from (1) the pine of the l lu le l the supra pinous ligament bet een them ( ) the sacral pines l le lateral sacral tubercles and, bet een them

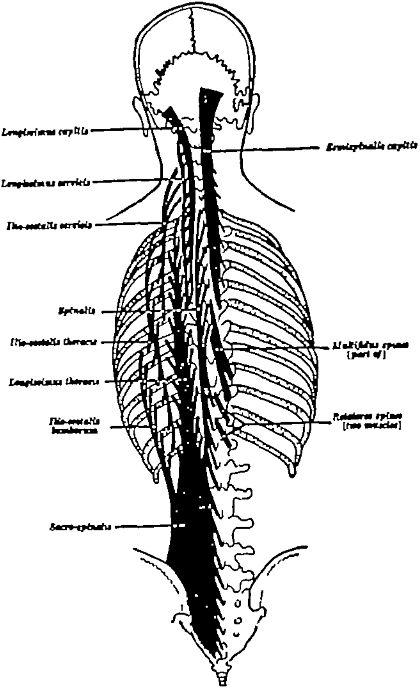


FIG. 28.

A scheme of the arrangement of the spinal muscles. The longitudinal muscles (sacro-spinalis and spinalis systems) are shown on the left side and the oblique muscles (semispinalis, multifidus, and rotatores muscles) on the right side.

the dorsum of the sacrum, the upper part of the coccyx, and the sacro-coccygeal ligaments, and (3) the posterior sacro-iliac ligaments; and by more fleshy fibres from the posterior part of the iliac crest and the deep surface of the superficial layer of the lumbar fascia. The muscle forms the large undivided mass which fills the lumbo-sacral part of the vertebral groove; but just below the last rib it divides into two columns of extension. The lateral ilio-costalis column follows the line of the angles of the ribs and the medial longissimus column that of the transverse processes.

The ilio-costalis column continues upwards the fleshy marginal part of the common mass and lying on the ribs medial to their angles, extends into the lower part of the neck. It is inserted by a continuous series of small flattened tendons which appear on its superficial surface, into the angles of the ribs and the transverse processes of the lower four or five cervical vertebræ that is, as a muscle of the back it ends below the lower limit of the insertion of the splenius cervicis, a muscle of the head and neck. The upper part of the column is reinforced by two series of slips of origin from the ribs, and on this account the column is subdivided, very artificially into three segments.

The ilio-costalis lumborum is inserted by flattened tendons into the lower borders of the angles of the lower six or seven ribs. The lateral (cutaneous) branches of the posterior primary rami of the lower thoracic nerves make their exit between it and the longissimus thoracis and are to be secured.

The ilio-costalis thoracis is reinforced by slender tendons from the upper borders of the angles of the lower six ribs, attached medial to the tendons of insertion of the ilio-costalis lumborum. It is inserted into the angles of the upper six ribs and the back of the transverse process of the seventh cervical vertebra.

The ilio-costalis cervicis is reinforced by four slips from the angles of the third, fourth, fifth, and sixth ribs, attached medial to the tendons of the ilio-costalis thoracis, and is inserted into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ. The ilio-costalis thoracis must be everted to display it.

The longissimus column is larger and more powerful than the ilio-costalis column. It consists of three parts which are easily separated from one another but the medial border of the lowest part is blended with the spinalis and the interval between the two systems is difficult to define it will become apparent if the surface of the muscles is cleaned, and emerging in its upper part are the medial (cutaneous) branches of the posterior primary rami of the upper thoracic nerves. The two systems are then to be separated from above downwards.

The longissimus thoracis has two rows of slips of insertion (1) a medial row of tendinous slips attached to the accessory processes of the lumbar vertebræ and the tips of the transverse processes of all the thoracic vertebræ; and (2) lateral row of muscular slips attached to the posterior surface of the middle layer of the lumbar fascia, the transverse processes of the lumbar vertebræ and the lower ten ribs between their tubercles and angles.

The longissimus cervicis lies medial to the longissimus thoracis and is

usually connected to it by tendinous slips. It arises by slender tendons from the transverse processes of the upper four thoracic vertebræ and is inserted along its lateral border by tendinous slips into the posterior tubercles of the transverse processes of the second to the sixth cervical vertebræ.

The **longissimus capitis** arises by tendons from the transverse processes of the upper four thoracic vertebræ and the articular processes of the lower four cervical vertebræ and as a narrow fleshy ribbon ascends to be inserted into the posterior margin of the mastoid process under cover of the splenius capitis. Some care is required to separate its lower part from the longissimus cervicis on the medial side of which it lies.

(2) The **spinalis system** of the post vertebral musculature includes the spinalis and inter-spinales muscles (p. 69). Little time is to be spent on their examination.

The **spinalis** is a long narrow muscle attached to the thoracic spines; it is closely blended below with the longissimus thoracis on the medial side of which it is placed and with the semispinalis thoracis on which it lies. It may be considered to arise from the spines of the upper two lumbar and the eleventh and twelfth thoracic vertebræ, the origin being by tendinous slips; and it is inserted by tendinous slips into the spines of the upper thoracic vertebræ, the number varying from four to eight. The muscle is often described as a third division of the sacro-spinalis system; it is supplied, however, by the medial branches of the posterior primary rami of the spinal nerves.

There are sometimes slips of muscle attached by tendons to the spinous processes of the cervical and lumbar vertebræ; they are known as the **spinalis cervicis** and the **spinalis lumborum**.

The **inter-spinales** muscles are placed in pairs between the spinous processes of adjoining vertebræ, one muscle lying on each side of the interspinous ligament. They are most distinct in the cervical region where they occupy each interspinous interval except that between the atlas and the axis. They are present only at the upper and lower parts of the thoracic region, being absent where the spinous processes greatly over-ride one another. In the lumbar region they extend the whole length of the spinous processes; the last muscles pass between the fifth lumbar and first sacral vertebræ.

(3) The longissimus thoracis and the spinalis are to be cut away to expose the **muscles of the oblique system** of the back (p. 69); they are a group whose fibres run obliquely, arising from the transverse processes of one series of vertebræ and being inserted into the spinous processes of a higher series (Fig. 28). Their general direction is, therefore, upwards and medially. The muscles are arranged in three layers according to the length and obliquity of their fibres. The superficial layer is the least oblique, and its fibres cross over five or more vertebræ between their origin from the transverse processes below and their insertion into the spinous processes above. This layer is named the **semispinalis**, and of it there are three parts, the **semispinalis thoracis**, **semispinalis cervicis**, and **semispinalis capitis**. The semispinalis capitis is fully exposed at the present time and is to be cleaned and its attachments defined with some care, and while doing so the **occipital artery** which

crosses its upper part, and the *medial branches of the posterior primary rami* of the second, third, fourth, and fifth cervical nerves, which pierce it close to the middle line, are to be preserved

The semispinalis capitis (complexus muscle) lies in the back of the neck beneath the splenius muscle and medial to the longissimi cervicis et capitis; as the uppermost part of the system to which it belongs and by its attachment to the head it is a specialised and well-defined muscle. It arises by a series of tendons from the tips of the transverse processes of the upper six thoracic and the seventh cervical vertebræ and from the articular processes of the fourth, fifth, and sixth cervical vertebræ. The tendons give place to a broad thick muscle which ascends to be inserted into the medial part of the area between the superior and inferior nuchal lines of the occipital bone (Fig 28). The most medial part of the muscle is more or less distinct from the general mass and is usually named the biventer cervicis since it is intersected by an imperfect tendinous septum. The muscles of the two sides are separated from one another in the cervical region by the ligamentum nuchæ (Fig. 4); occasionally the lower parts have slips of origin from the thoracic spinous processes.

The occipital artery should be studied in the further part of its course which is now exposed. It will be seen to emerge from under the mastoid process if the longissimus capitis muscle which covers it is divided and turned upwards occasionally however the artery lies superficial to this muscle. From the mastoid process the occipital artery passes horizontally backwards just below the superior nuchal line being covered by the splenius capitis and sterno-mastoid muscles and resting on the semispinalis capitis. Emerging from the posterior border of the sterno-mastoid muscle, it crosses the apex of the posterior triangle of the neck and turns upwards to reach its distribution on the scalp (Fig. 22)

The branches of the occipital artery in this part of its course are (1) muscular twigs t the surrounding muscles; (2) meningeal branch which enters the skull through the mastoid foramen supplies the dura mater and the bone; and (3) the descending cervical artery vessel of some size which runs to the lateral border of the semispinalis capitis and there divides into superficial and deep branches. The superficial branch ramifies on the surface of the semispinalis capitis while the deep branch descends beneath it to anastomose with the deep cervical artery This anastomoses will be exposed when the muscle is reflected

The semispinalis ca tis is to be reflected. The medial edge of the muscle is to be defined in its whole length any slips of attachment to the thoracic spines being cut through. The muscle is then to be gradually raised by working underneath it with the handle of the scalpel and, when it deep urface has been freed, it is to be divided transversely about half an inch below ts occipital attachment and turned laterally There is often some difficulty in performing this dissection neatly and t th same time preserving intact the tructures which lie below the muscle and the nerves which pierce it. Its upper

part lies over the muscles which bound the **sub-occipital triangle** while below it covers the **semispinalis cervicis** muscle. A dense fascia overlies these parts. In this fascia the dissector must define the **deep cervical artery**, which springs, on the front of the neck, from the costo-cervical branch of the subclavian artery, and reaches its present position by passing backwards between the transverse process of the seventh cervical vertebra and the neck of the first rib. It ascends on the lateral part of the semispinalis cervicis to anastomose with the descending cervical branch of the occipital artery. The artery is accompanied by a large vein or a plexus of veins which begins in the sub-occipital triangle and ends in the vertebral vein on the front of the neck; it reaches it by turning forwards below the transverse process of the seventh cervical vertebra.

There are also to be found in the fascia branches of the **posterior primary rami of the cervical nerves.** The posterior ramus of the first or sub-occipital nerve will be dissected later, though the branch from it to the semispinalis capitis should be sought now; it enters the deep surface of its upper part. The posterior rami of the cervical nerves below the first divide into medial and lateral branches. The **medial branches** of the second and the immediately succeeding nerves are large, especially the branch of the second nerve which is the **great occipital nerve**; it is to be traced through the semispinalis capitis and preserved, but only one or two of the lower branches should be dissected. **The lateral branches** are much smaller than the medial branches. They are to be sought beyond the lateral edge of the semispinalis capitis, the attachments of which to the articular processes of the cervical vertebræ are to be cut through; they end in the splenius and the upper parts of the sacro-spinalis system.

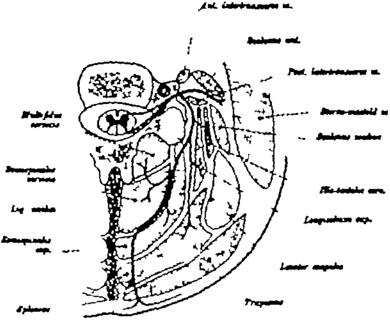
At the present time the student should also make a general survey of the posterior primary rami of the thoracic, lumbar and sacral nerves; one nerve of each region should be taken as an example and its course and distribution examined.

The **posterior primary rami of the spinal nerves** are the nerves of the back; they supply the post-vertebral muscles and the skin of the back. Typically each ramus divides into medial and lateral branches, but the first cervical, fourth and fifth sacral, and coccygeal rami do not so divide. Both medial and lateral branches carry motor fibres to the spinal muscles; in the neck and the upper part of the back the sensory fibres of the skin are carried in the medial branches, in the lower part of the back they are carried in the lateral branches.

Cervical Nerves.—The posterior ramus of the first cervical (sub-occipital) nerve does not divide into medial and lateral branches. It is distributed to the muscles of the sub-occipital triangle, where it will be dissected, and gives a branch to the semispinalis capitis.

The other cervical nerves divide into medial and lateral branches (Fig. 20). The lateral branches are of small size and end in those parts of the sacro-spinalis system which lie in the cervical region, namely the ilio-costalis cervicis, the longissimus cervicis et capitis, and the splenius. The medial branches

of the second, third, fourth, and fifth nerves run medially between the semispinalis cervicis and the semispinalis capitis giving twigs to both muscles and the multifidus cervicis in their course; and close to the middle line they pierce the semispinalis capitis and the splenius and the trapezius and become cutaneous, the branch of the second nerve being the great occipital and that of the third the third occipital nerve. The occipital nerves ascend to the posterior part of the scalp, the others run more or less transversely across the neck (Fig. 22). The medial branches of the lower three cervical nerves run medially



F[illegible] 29

Diagram [illegible] trans[illegible] section of the back of the neck to show the course and dist[illegible]bu[illegible]on of the p[illegible] [illegible]rior primary ramus of the fourth cervical nerve. The foll[illegible]ing part[illegible] of the [illegible]p[illegible]n[illegible] nerve are t[illegible] be named the anterior and post[illegible]rior [illegible] [illegible]he gangl[illegible]on of the posterior root the anterior primary ramus (it[illegible] course [illegible] b[illegible]t[illegible] the int[illegible]rtra[illegible] [illegible]erse muscles and the scalenus anterior and scal[illegible]us med[illegible]us) and the p[illegible]st[illegible]rior primary ramus

deep t[illegible] the semispinal[illegible] [illegible] [illegible] and the multifidus cervicis as a rule they do not gi[illegible] [illegible] [illegible] branches, being entirel[illegible] expended in the semispinalis and multifi[illegible] [illegible]

Thoracic Nerves. Th[illegible] medial branches of the posterior rami of the upper six thoracic nerves (Fig. [illegible]) [illegible] [illegible] the semispinalis thoracis and the multifidus [illegible] [illegible] [illegible] the [illegible] [illegible] [illegible] the spin[illegible] muscle they suppl[illegible]. They then pierce the semispinal[illegible] [illegible] [illegible] [illegible] and trapezius m[illegible]les and become cutaneous [illegible] [illegible] [illegible] [illegible] the posterior [illegible] cutaneous nerves. The medial branche[illegible] [illegible] [illegible] [illegible] six nerves are small and are

expended in supplying the spinalis, semispinalis, and multifidus muscles (Fig. 31). The **lateral branches** increase in size from above downward. They proceed laterally through or beneath the longissimus dorsi to the interval between it and the ilio-costalis and they supply the thoracic parts of these systems. The lower five or six nerves also give off cutaneous branches which emerge between the longissimus and ilio-costalis and pierce the serratus posterior inferior and the latissimus dorsi in a line with the angles of the ribs.

Lumbar Nerves.—The **medial branches** of the posterior rami of the five lumbar nerves are small, and are distributed to the multifidus muscle. The **lateral branches** supply the sacro-spinalis muscle. The upper three of them are of large size and give off cutaneous branches which pierce the fleshy part of the ilio-costalis and the aponeurosis of the latissimus dorsi and descend

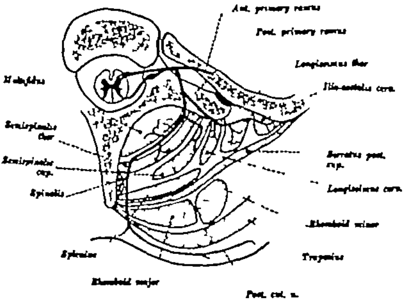


FIG. 30.

Diagram of a transverse section of the back at the level of the second thoracic vertebra to show the arrangement of the spinal muscles and the course and distribution of the posterior primary rami of the upper thoracic nerves.

across the iliac crest to the skin of the gluteal region. They have been examined by the dissectors of the lower limb.

Sacral Nerves.—The posterior rami of the sacral nerves are small. The upper four emerge through the posterior sacral foramina and the fifth at the lower end of the sacral canal. The upper three nerves lie under cover of the multifidus muscle and divide into medial and lateral branches. The medial branches are very fine and end in the multifidus. The lateral branches are larger and join with one another to form loops on the dorsal surface of the sacrum. A second series of loops is formed from the first series on the surface of the sacro-tuberous ligament under the gluteus maximus muscle, and from them two or three cutaneous branches are given off; they pierce the gluteus maximus and supply the skin over the posterior part of the buttock.

The posterior rami of the lower two sacral nerves do not divide into

of the second, third, fourth, and fifth nerves run medially between the semispinalis cervicis and the semispinalis capitis giving twigs to both muscles and the multifidus cervicis in their course; and close to the middle line they pierce the semispinalis capitis and the splenius and the trapezius and become cutaneous, the branch of the second nerve being the great occipital and that of the third the third occipital nerve. The occipital nerves ascend to the posterior part of the scalp, the others run more or less transversely across the neck (Fig. 22). The medial branches of the lower three cervical nerves run medially

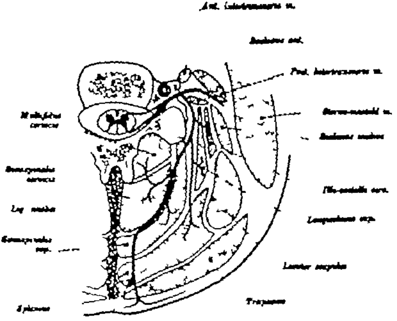


Fig. [illegible]

Diagram of [illegible] transverse [illegible] the back of the neck to show the course and distribution [illegible] primary ramus of the fourth cervical nerve. The [illegible] named [illegible] the anterior and post[illegible] post[illegible] root the anterior primary ramus [illegible] muscles and the scalenus anterior and scal[illegible] med[illegible] [illegible] primary ramus

deep t[illegible] the semispinalis [illegible] t and the multifidus cervicis; as rule the [illegible] branches being entirely expended in the semispinales and multifid[illegible].

Thoracic Nerves. The medial branches [illegible] the posterior rami of the upper six thoracic nerves (Fig. [illegible]) [illegible] the semispinalis thoracis and the multifidus muscle both [illegible] the spinal [illegible] they supply. They then pierce the semispinalis [illegible] and trapezius muscles and become cutaneous [illegible] as the posterior cutaneous nerves. The medial branches [illegible] six nerves are small and are

The semispinalis thoracis and cervicis are to be detached from the spinous processes and thrown laterally and the sacro-spinalis mass is to be removed from the lumbar region and the sacrum. A mass of muscle will be exposed extending from the sacrum below to the axis above whose fibres have the same direction and belong to the same system as the semispinales they are however more oblique than those of the semispinales and the bundles in which they are grouped are shorter and pass over two three or four vertebræ (Fig 28) The whole mass of muscle which is thus arranged is named the **multifidus muscle.**

The multifidus muscle fills the groove at the side of the spines of the vertebræ It forms a thick fleshy mass in the sacral and lumbar regions. It arises there from the back of the sacrum, the posterior sacro-iliac ligaments, the posterior superior iliac spine and the mamillary processes of the lumbar vertebræ; in the thoracic region it arises from the transverse processes of all the vertebræ and in the cervical region from the articular processes of the lower four vertebræ. The most superficial fibres are the longest and pass over three or four vertebræ while the deepest fibres are the shortest and pass over no more than two vertebræ; they are inserted into the spinous processes of the movable vertebræ as high as the axis. The muscle is less developed in the thoracic region than above and below

The third and deepest layer of the oblique fibres is to be found only in the thoracic region, and will be exposed by cutting away the fibres of the multifidus muscle It will then be seen to consist of small quadrate muscles which arise from the transverse processes and are inserted into the spinous processes of the vertebræ immediately above They are specially named the **rotatores spinæ** though they may well be regarded as the deepest slips of the multifidus muscle (Fig 28)

The rotatores spinæ muscles are usually confined to the thoracic region and are eleven in number on each side; this number may be diminished, however by the absence of one or more at the upper or lower end of the series. Each is a small quadrate muscle which arises from the root of the transverse process of one vertebra and is inserted into the lamina and the root of the spinous process of the vertebra immediately above

(4) The fourth group of the post-vertebral muscles (p 69) comprises the **inter-transversales** little time should be spent on their examination.

The inter-transverse muscles are placed between the transverse processes of the vertebræ. They are best developed in the cervical region, but are *not* to be dissected there at present. In the thoracic region they are found only in the lower three or four spaces. In the lumbar region they are well defined muscles, and are arranged in pairs on each side. The lateral muscle of each pair occupies the entire interspace between the transverse processes of the lumbar vertebræ, and its nerve supply is from the anterior primary ramus of the lumbar nerve; it does not properly belong, therefore, to the post vertebral musculature. The medial muscle passes from the mamillary process of one vertebra to the accessory process of the vertebra above Its nerve supply is from the posterior primary ramus.

medial and lateral branches. They are very small, and, having united with one another and with the posterior ramus of the coccygeal nerve they distribute small filaments to the skin over the coccyx.

Coccygeal Nerve.—The posterior ramus of the coccygeal nerve does not divide into medial and lateral branches, but after communicating with the posterior ramus of the last sacral nerve is distributed to the skin over the coccyx.

The general arrangement of the **semispinalis cervicis** and **semispinalis thoracis** is now to be examined but little time should be given to the dissection of the muscles. Both muscles are fully exposed.

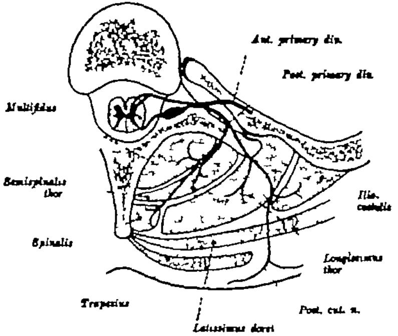


Fig. 31

Diagram of a transverse section of the back at the level of the eighth thoracic vertebra to show the arrangement of the spinal muscles and the course and distribution of the posterior primary rami of the lower thoracic nerves.

The **semispinalis cervicis** lies under cover of the semispinalis capitis. It is more fleshy in its structure than the semispinalis thoracis. It arises by a series of slips from the transverse processes of the upper five thoracic vertebræ and is inserted into the spinous processes of the second to the fifth cervical vertebræ. The slip to the spine of the axis is the largest.

The **semispinalis thoracis** consists of thin muscular slips with long tendons of origin and insertion. They are attached below to the transverse processes of the sixth to the tenth thoracic vertebræ and above to the spinous processes of the upper four thoracic and lower two cervical vertebræ.

the floor of the triangle there should first be palpa
and then exposed by removing the fibrous tissu
posterior arch of the atlas, and above it the thin

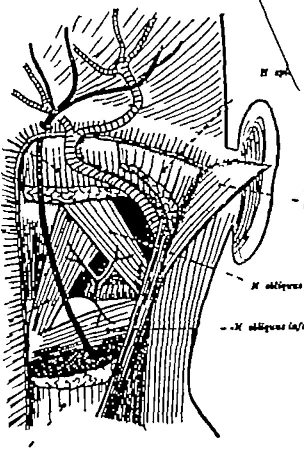


FIG. 33.

Dissection of the sub-occipital triangle The trapezius muscle has been removed; in the triangle there are the vertebral artery the sub-occipital nerve the posterior arch of the atlas, and the posterior atlanto-occipital membrane. The course and relations of the great occipital nerve and the occipital artery are to be studied the vertebral and occipital arteries are to be coloured.

occipital membrane and in the vertebral groove of the atlas the **vertebral artery** is to be found and cleaned as far as the limits of the space permit (Fig 33)

The first cervical spinal nerve leaves the vertebral canal between the occipital bone and the atlas and on this account is usually named the

The Sub-occipital Triangle

At the upper part of the neck and under cover of the semispinalis capitis muscle (which has been reflected) there is a small triangular space named the **sub-occipital triangle**. It contains and is overlaid by a dense tough fibro-fatty tissue which renders the dissection of the triangle difficult. This tissue, however is to be gradually cleared away and while doing so the dissector should note the large number of small veins embedded in it they form the **sub-occipital venous plexus**.

The **sub-occipital venous plexus** comprises a large number of small veins which occupy the sub-occipital triangle and are embedded in the covering fascia. They include branches from the occipital vein, numerous small veins from the skin and muscles of the upper part of the neck, and tributaries which communicate with the veins of the vertebral canal. The plexus is drained partly by the radicles of the vertebral vein and partly by the deep cervical vein; the latter vein has already been dissected in company with its artery (p. 75).

As the fibrous tissue is cleared away the muscles which bound the triangle will be brought into view. They are, the **obliquus capitis inferior** which bounds it below and is easily found since the great occipital nerve hooks round its lower border the **obliquus capitis superior** which bounds it on the lateral side and the **rectus capitis posterior major** muscle which forms its upper and medial boundary (Fig 33). These muscles are to be cleaned and their attachments defined, and under the rectus capitis major muscle the small **rectus capitis posterior minor** is to be exposed (Fig 33).

The **obliquus capitis inferior**, the larger of the two oblique muscles, arises from the apex of the spinous process of the axis and extends laterally and only slightly upwards to be inserted into the lower and back part of the transverse process of the atlas.

The **obliquus capitis superior** has a narrow origin from the upper surface of the transverse process of the atlas. It broadens considerably as it runs upwards and medially to be inserted into the occipital bone deep to the lateral part of the semispinalis capitis; it overlies the insertion of the rectus capitis posterior major

The **rectus capitis posterior major** arises by a narrow pointed tendon from the spinous process of the axis. It becomes broader as it ascends, and is inserted into the lateral part of the inferior nuchal line of the occipital bone and the area immediately below The muscles of the two sides diverge as they pass upwards and in the interval between them the recti minores are seen.

The **rectus capitis posterior minor** arises by a narrow tendon from the tubercle on the posterior arch of the atlas, and widening it ascends to be inserted into the medial part of the inferior nuchal line of the occipital bone and the area between it and the foramen magnum.

While these muscles are being defined the dissector should secure the small branches of the sub-occipital nerve which supply them. In

head to the opposite side and depressing the chin It then becomes a prominent landmark thick and rounded above and cord like below where it passes into the sternal origin of the muscle The posterior border of the contracted muscle cannot be so distinctly seen or felt except in its lower third where it is continued into the clavicular head The interval between the two heads of the sterno-mastoid muscle is indicated by the shallow **lesser supra-clavicular fossa**, bounded below by the clavicle it is in this fossa that a jugulo-carotid pulse tracing is taken for the common carotid artery and the internal jugular vein lie deep to it The **greater supra-clavicular fossa** lies lateral to the clavicular head of the sterno-mastoid muscle it becomes more evident when the clavicle is raised as when the shoulders are shrugged It is crossed by the **posterior belly of the omo-hyoid muscle**, which can be felt and often seen in thin people especially in inspiration and sometimes when talking below the muscle lie the **brachial plexus**, a leash of firm cords, and close to the clavicle the **subclavian artery** whose pulsations can sometimes be felt. The sterno-mastoid muscle is crossed vertically by the **external jugular vein** which can usually be seen it lies along a line from the angle of the jaw to the middle of the clavicle.

The body of the **hyoid bone** is to be palpated in the middle line of the neck in the normal position of the head it lies about two inches behind and on the same level as the point of the chin or even slightly above it Above and in front of the hyoid is the **floor of the mouth.** The greater cornua of the hyoid bone can be felt if the whole bone is gripped between the finger and the thumb and it is usually possible to follow them to their ends which lie at or even under cover of the anterior border of the sterno-mastoid muscles. The anterior angular edge (pomum Adami of the male) and the upper margin of the **thyroid cartilage** are easily distinguished the upper margin can be followed backwards to the upward projection (superior horns) at its ends. It is at this level that the **common carotid artery** divides into the **internal and external carotid arteries** (Fig 7) and close to the horns the pulsations of the vessels can sometimes be seen The interval between the hyoid bone and the thyroid cartilage the **thyro-hyoid space**, is to be carefully palpated and the student is to study on his own neck the differences in its size when the head is flexed and extended and during the process of swallowing It is filled by the **thyro-hyoid membrane.** Below the thyroid cartilage the rounded anterior part of the **cricoid cartilage** can be felt when the head is erect it lies on the level of the sixth cervical vertebra and about one and a half inches above the supra sternal notch but when the head is thrown backwards it rises about half an inch The cricoid cartilage marks the lower limit of the larynx (p 11) between it and the thyroid cartilage i the **crico-thyroid space**, filled by the **crico-thyroid membrane**, and should its upper part become blocked the larynx may be opened here to allow air to enter the trachea Below the cricoid the rings of the **trachea** can usually be recognised but the trachea recedes from the surface as it descends in the deep V shaped interval between the sternal heads of the sterno-mastoid

The platysma is then to be carefully divided along the line of the clavicle and reflected from below upwards as an entire sheet and while this is being done the following structures which lie in the superficial fascia deep to it are to be secured and cleaned (Fig 31) (1) The **cervical branch of the facial nerve** emerges from the lower end of the parotid gland pierces the deep fascia of the neck near the angle of the jaw and runs a short distance forwards under cover of the platysma and supplies it it communicates with the upper branch of the anterior cutaneous nerve of the neck and is continued over the lower border

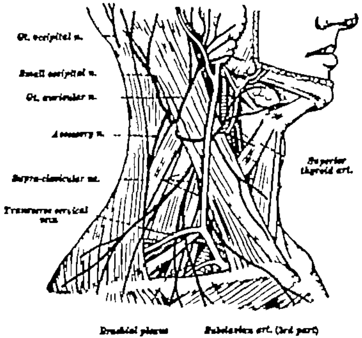


Fig. 31.

Superficial dissection of the front and side of the neck the platysma muscle having been removed. The external jugular vein and its tributaries are to be coloured

of the jaw to supply the depressor anguli oris. It is in danger in all incisions near the angle of the jaw a temporary asymmetry of the mouth will be produced if it is cut. ( ) The **external jugular vein** (see p 88) (3) The **anterior cutaneous nerve of the neck**, a branch of the cervical plexus (C 2 and 3) pierces the deep fascia of the neck at the middle of the posterior border of the sterno-mastoid muscle and passes forwards over the muscle in the superficial fascia either superficial or deep to the external jugular vein It divides into upper and lower branches which pierce the platysma and are distributed to the skin of the front of the neck (Fig. 31). (4) The **anterior jugular vein** (see p 93)

muscles and it is fully one and a half inches behind the upper edge of the sternum. The upper part of the trachea is crossed by the **isthmus of the thyroid gland** (p. 15): it is fairly easily felt in the living subject as a soft mass half an inch below the cricoid cartilage. The lateral lobes of the gland lie on the sides of the larynx and upper part of the trachea.

Superficial Dissection of the Front of the Neck

Reflection of the skin.—An incision is to be made in the skin in the middle line of the neck from the chin to the sternum, and from its lower end another incision is to be carried along the clavicle to the acromion process. The flap thus marked out is to be reflected backwards so that, with the parts of the skin already removed from the back, the whole surface of the neck becomes uncovered. The skin is to be removed altogether; but in the intervals of dissection moistened cloths should be wrapped round the neck to keep the tissues soft.

The **superficial fascia** of the neck is exposed. It varies in thickness with the amount of fat it contains; often this is in some quantity under the jaw, producing the condition of double chin, but as a rule it is much less in men than in women and children, in whom it gives the even contour to the neck. It is only loosely connected to the skin, which is therefore freely movable over all the front of the neck. In the fascia there lie the fibres of the **platysma muscle.** This is a broad thin sheet which commences below over the upper part of the chest and runs upwards and forwards the whole length of the neck and over the lower jaw onto the face, where it has already been dissected with the facial muscles to which group it belongs. It is supplied by the **cervical branch of the facial nerve** (p. 43).

The **platysma** is a broad sheet of pale muscle fibres which *arises from the* skin and in the superficial fascia covering the upper parts of the pectoralis major and deltoid muscles. They proceed obliquely upwards and forwards across the clavicle and along the side of the neck towards the lower jaw; the back part of the muscle covers the subclavian triangle. The posterior fibres cross the mandible and are inserted with the other facial muscles about the angle of the mouth and the lower part of the face (Fig. 13). The anterior fibres are inserted into the lower border of the jaw from the middle line to the masseter muscle, the most anterior fibres decussating with those of the opposite side for about an inch below the chin.

The muscle is the most superficial structure in the superficial fascia of the neck and through this some attachment to the skin of the neck. Its anterior edge often produces in old people a fold of the skin which runs downwards and laterally from the chin.

The platysma is [illegible] below the clavicle by the three sets of **supra-clavicular nerves**, branches of the cervical plexus (C. 3 and 4), which are distributed to the skin of the [illegible] upper parts of the chest. These nerves are to be secured in conjunction with the dissectors of the arm.

varies a good deal in size depending on the size of the anterior division of the *posterior* facial vein (Fig 8). It can often be seen through the skin in the living subject. It commences at the lower margin of the parotid gland by the union of the posterior auricular vein and the posterior division of the posterior facial vein (Fig 8), and runs vertically down the neck in the superficial fascia under the platysma muscle. The anterior cutaneous nerve of the neck passes forwards either superficial or deep to it. In its course it crosses the sterno-mastoid muscle obliquely and at the posterior border of the muscle it enters the subclavian triangle by piercing the superficial layer of the deep fascia; sometimes however it pierces the fascia above the posterior belly of the omo-hyoid muscle. It then descends between the two layers of the fascia, crossing the lower root of the brachial plexus; and after piercing the deep layer of the *fascia it passes superficial to the subclavian artery* and ends in the subclavian vein. Its tributaries are the transverse cervical, supra-scapular and anterior jugular veins, and there often join it at the posterior border of the sterno-mastoid muscle the posterior external jugular vein which descends over the posterior triangle from the occipital region; these vessels join it while it lies between the two layers of the deep fascia.

The external jugular vein has a valve just above its termination, and a second valve is present about the middle of the neck (Fig 35). As it pierces the superficial layer of deep fascia its walls are adherent to it. Its lower part is thus prevented from collapsing should the amount of blood in it be deficient and this predisposes to the entrance of air into it if it is divided in the living subject. *The terminal part of the vein sometimes inclines medially under the* sterno-mastoid muscle and it may even end in the internal jugular vein.

The deep layer of the deep fascia is continuous above with the fascia round the **posterior belly of the omo-hyoid muscle**. It is to be carefully removed and the muscle defined but that part of it which attaches the tendon of the muscle to the sternum is to be left intact. The muscle itself is to be gently turned downwards and the slender nerve which supplies it secured; it enters its deep surface near the sterno-mastoid muscle.

The **posterior belly of the omo-hyoid muscle** (Fig 35) arises from the supra-scapular ligament and the upper border of the scapula medial to it. It enters the posterior triangle of the neck at its lower and posterior angle and runs upwards and forwards, at only a short distance above the clavicle to the posterior border of the sterno-mastoid muscle under which it passes; it joins the intermediate tendon which connects it to the anterior belly of the muscle. It divides the posterior triangle into occipital and subclavian parts. There have already been secured deep to it the upper part of the brachial plexus, the supra-scapular nerve and the transverse cervical artery.

The **boundaries of the subclavian triangle** are now clearly defined namely the omo-hyoid muscle above the sterno-mastoid muscle in front, and the clavicle below (Fig 25). The **floor of the triangle** is formed very largely by the first rib; above it are the lower part of the scalenus medius laterally and the scalenus anterior medially, both of which are attached to the rib. The clavicle is to be depressed as far as possible by dragging on the arm, and in the triangle the following structures are to be dissected (Fig. 35) —

towards the axilla. This part of the plexus lies partly in the occipital and partly in the subclavian triangle being crossed by the omo-hyoid muscle The upper trunks of the plexus are crossed by the **transverse cervical artery** after it leaves the scalenus anterior No detailed study need be made of the plexus at this stage of the di section but two of its branches should be secured namely (1) the **supra-scapular nerve** which runs downwards and backwards above and lateral to the plexus and passes under the omo-hyoid, and (2) the **nerve to the rhomboids** which lies a little higher above the omo-hyoid, and disappears through the floor of the occipital triangle

3. Only a small part of the **subclavian artery** lies in the triangle and the **subclavian vein** lies below the artery and as a rule wholly behind the clavicle and therefore outside the triangle The artery is deeply placed but the student will readily find it by dissecting below the brachial plexus and removing a third layer of deep fascia which covers it this fascia is the highest part of the axillary sheath The artery rests behind on the dome of the pleura and lateral to it on the first rib against which it can be compressed and anterior to it there are the following structures the skin the superficial fascia with the platysma muscle the supra-clavicular nerves the deep fascia arranged in two layers the terminal parts of the external jugular vein and its lateral tributaries the supra-scapular artery and the **nerve to the subclavius muscle** This is a slender nerve which arises above the omo-hyoid from the front of the brachial plexus close to the sterno-mastoid it runs downwards under the omo-hyoid crosses in front of the subclavian artery and ends in the subclavius muscle (Fig 35)

The subclavian artery i the artery of the upper limb and in its course to the axilla its terminal, or third, part crosses the subclavian triangle at the root of the neck. This part of the artery begins t the lateral border of the scalenus anterior muscle, from below which it emerges and runs downwards and laterally to the outer border of the first rib where it ends by becoming the axillary artery It rests behind and below on the cervical pleura, the insertion of the scalenus medius and, below the muscle on the upper surface of the first rib; the lowest trunk of the brachial plexus intervenes between it and the scalenus medius. The upper trunks of the brachial plexus, the transverse cervical artery the supra-scapular nerve, and the posterior belly of the omo-hyoid muscle lie proximal to it; while distal to it, and on a more anterior plane, is the subclavian vein.

The lateral border of the lower part of the scalenus anterior it is to be noted, coincides with the posterior border of the sterno-mastoid or is very little lateral to it. The subclavian artery is thus comparatively superficial as it emerges from the scalenus anterior but when it passes onto the first rib it lies behind the clavicle the most distal part of the artery therefore cannot be seen. The superficial relations of the part of the artery above the claviel have been enumerated above; it ha only to be added that the supra-scapular and transverse cervical veins are often connected by cross branches which form troublesome network in front of the artery in its exposure in the living subject. The position and course of the rtery are represented by a line from point on the posterior border of the sterno-mastoid muscle half an inch abov the clavicle to a point on the lower border of the middle of the clavicle.

1 The supra-scapular artery runs across the lower part of the scalenus anterior and then laterally and downwards behind the middle third of the clavicle in front of the subclavian artery; strictly speaking it is here outside the triangle for it lies between the calvicle and the

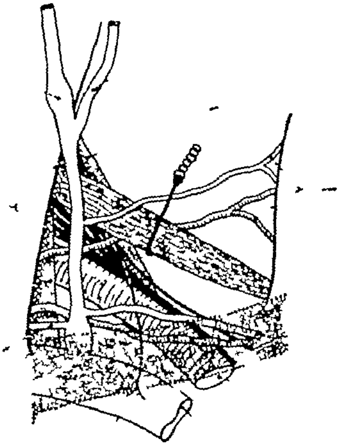


FIG. 25.

Dissection of the posterior triangle of the neck. The omo-hyoid muscle has been pulled upwards; the clavicle is shown stippled. The structures are to be named and the arteries and veins are to be coloured. The swellings on the veins are at their valves.

deep layer of the deep fascia. At the posterior angle of the triangle it meets the suprascapular nerve and descends with it to the suprascapular notch of the scapula.

The upper part of the brachial plexus emerges at the lateral border of the scalenus anterior and runs downwards and laterally

towards the axilla This part of the plexus lies partly in the occipital and partly in the subclavian *triangle being crossed by the omo-hyoid* muscle The upper trunks of the plexus are crossed by the **transverse cervical artery** after it leaves the scalenus anterior No detailed study need be made *of the plexus at this stage of the dissection* but two of its branches should be secured namely (1) the **supra-scapular nerve** which *runs downwards and backwards* above and lateral to the plexus and passes under the omo-hyoid and (2) the **nerve to the rhomboids** which lies a little higher above the omo-hyoid and disappears through the floor of the occipital triangle

3. Only a small part of the **subclavian artery** lies in the triangle and the **subclavian vein** lies below the artery and as a rule wholly behind the clavicle and therefore outside the triangle The artery is deeply placed but the student will readily find it by dissecting below the brachial plexus and removing a third layer of deep fascia which covers it this fascia is the highest part of the axillary sheath The artery rests behind on the dome of the pleura and lateral to it on the first rib against which it can be compressed *and anterior to it* there are the following structures the skin, the superficial fascia with the platysma muscle, the supra-clavicular nerves the deep fascia *arranged in two layers, the terminal parts* of the external jugular vein and its lateral tributaries, the supra scapular artery and the **nerve to the subclavius muscle** This is a slender nerve which arises above the omo-hyoid from the front of the brachial plexus close to the sterno-mastoid it runs downwards under the omo-hyoid crosses in front of the subclavian artery and ends in the subclavius muscle (Fig 35).

The subclavian artery is the *artery of* the upper limb and in it course to the axilla its terminal, or third, part crosses the subclavian triangle at the root of the neck. This part of the artery begins t the lateral border of the scalenus anterior muscle from below which t emerges and runs downwards and laterally to the outer border of the first rib where it ends by becoming the axillary artery It rests behind and below on the cervical pleura, the insertion of the scalenus medius and, below the muscle, on the upper surface of the first rib; the lowest trunk of the brachial plexus intervenes between it and the scalenus medius. The upper trunks of the brachial plexus, the transverse cervical artery the supra-scapular nerve, and the posterior belly of the omo-hyoid muscle lie proximal to it; while distal t it, and on a more anterior plane, is th subclavian vein

The lateral border of the lower part of the scalenus anterior it is to be noted, coincides with the posterior border of the sterno-mastoid or is very little lateral to it. The subclavian artery is thus comparat vely superficial as it emerges from the scalenus anterior but when it passes out the first rib it lies behind the clavicle; the most distal part of the artery therefore cannot be seen. The superficial relations of the part of the artery above the lavicle have been enumerated bove; it has only to be added that the supra scapular and transverse cervical veins are often connected by ross branches which form a troublesome network in front of the artery in ts exposure in the living subject. The position and course of the artery are represented by line from point on the posterior border of the sterno- mastoid muscle half an inch bove the clavicle to a point on the lower border of the middle of the clavicle.

The superficial fascia is to be cleared from the triangle so that the **investing layer of deep fascia** which covers the neck (p 10) may be examined This is a continuous layer of fine areolar tissue which extends from the sterno-mastoid muscle of one side to that of the other and from the lower jaw above to the sternum below it is firmly attached however to the body and great cornua of the hyoid bone Above the hyoid bone it consist of two layers the superficial of which is attached along the lower border of the mandible and behind the angle of the mandible extends upwards over the parotid gland and is attached to the zygomatic arch. This layer should be removed by dividing it at its mandibular attachment the **facial artery** and the **anterior facial vein** which pierce it being preserved The **submandibular salivary gland** will be exposed On the surface of the gland and in the interval between it and the jaw the **submandibular lymph glands** are to be sought and the anterior facial vein is to be traced across its posterior part and behind the gland and usually overlapped by it there are to be defined two slender muscles close together the **stylo-hyoid** above and the **posterior belly of the digastric** muscle below (Fig 36) If the submandibular gland is raised the deeper layer of the investing fascia will be seen, and if the handle of a knife is placed on it and pushed gently upwards it will pass as far as its attachment to the mylo-hyoid ridge on the deep surface of the mandible The submandibular gland, therefore is enclosed in a sheath formed by two layers of the upper part of the investing deep cervical fascia. The lower part of the investing fascia also consists of two layers. The superficial of them is attached below to the front of the sternum and is carried over the sterno-mastoid muscles at the sides It should be removed by incising it along the anterior borders of the sterno-mastoid muscles care being taken to preserve the anterior jugular veins. The space which is thus opened into is named the **supra-sternal space** (of Burns) and in it the lower parts of the anterior jugular veins, the transverse anastomosis between them some areolar tissue and sometimes a lymph gland will be found. The deeper layer of the fascia which forms the floor of the space is attached at the root of the neck to the posterior surface of the manubrium sterni while at the sides it passes deep to the sterno-mastoid muscles. When followed upwards it fuses with the superficial layer about midway between the sternum and the thyroid cartilage

The investing layer of deep fascia is to be removed from the anterior triangle to expose its contents. Below the hyoid bone there are to be defined and cleaned, without disturbing them in position three slender band like muscles which run more or less perpendicularly they are grouped together as the **infra-hyoid muscles** and form a sub-group of the rectus musculature of the neck (p. 9) (Fig 36) The lateral muscle is the **anterior belly of the omo-hyoid,** and that medial to it and on the same plane is the **sterno-hyoid** the third muscle the **sterno-thyroid,** lies deep to the sterno-hyoid, but its lower part is a little nearer the middle line and can be seen there from the surface. Beneath the upper

part of the sterno-hyoid a small quadrilateral muscle, the **thyro-hyoid**, is to be recognised It extends between the thyroid cartilage and the hyoid bone and also belongs to the infra-hyoid group. The infra hyoid muscles are invested by thin fascial sheaths which are continuous on their medial side with a median strip of areolo-fatty tissue. This tissue, more membranous in its deeper layers, covers the trachea and invests the thyroid gland, and is attached above to the thyroid cartilage It is known as the **pre-tracheal fascia** (p. 10) The nerves to the infra-hyoid muscles approach them from the lateral side (Fig. 36) they are slender twigs and care is to be taken not to break them.

The pre-tracheal fascia is to be removed from between the infra hyoid muscles of the two sides and in the median interval the following structures are to be exposed from above downwards —

1. The anterior part of the **thyroid cartilage** forms the prominence of the pomum Adami at its upper end and above it, in the thyro-hyoid interval, is the median part of the **thyro-hyoid membrane** which is known as the **median thyro-hyoid ligament**. The ligament is covered with a little loose areolar tissue but when this is cleared away it will be seen to be attached below to the upper border of the thyroid cartilage and to extend upwards deep to the body of the hyoid bone to be attached to its upper border between it and the hyoid bone is a small bursa which facilitates the movements of the thyroid cartilage in swallowing On the surface of the ligament there is a transverse anastomosis between the **infra-hyoid arteries**, branches of the superior thyroid arteries.

2. The rounded anterior arch of the **cricoid cartilage** is below the thyroid cartilage and between them is the **crico-thyroid ligament**. On the surface of the ligament, close to the thyroid cartilage, a transverse anastomosis between the **crico-thyroid arteries**, branches of the superior thyroid arteries, is to be sought.

3. The first ring of the **trachea** is united to the cricoid cartilage by the **crico-tracheal ligament**.

4 The **isthmus of the thyroid gland**, a narrow median transverse part overlies the second, third and fourth rings of the trachea. It is connected to the lower border of the thyroid cartilage by a band of pre-tracheal fascia which prevents it being displaced downwards. Occasionally a pyramidal process of the gland or a small slip of muscle (levator glandulae thyroideae) extend upwards from the isthmus. The muscle when it is present usually lies to the left of the middle line and is attached above to the lower border of the hyoid bone, while the pyramidal process may either end in a pointed extremity or be continued into a fibrous cord which passes deep to the hyoid bone the cord is the remains of the thyro-glossal duct

5 Below the isthmus of the thyroid gland the **trachea** recedes from the surface In the fatty tissue which covers it there are to be secured and cleaned the **inferior thyroid veins** (Fig 37) They pass downwards communicating freely with one another and disappear behind the sternum where they join the innominate veins. Sometimes

a small median artery the **thyroidea ima**, will be found ascending to the isthmus of the thyroid gland

The **supra hyoid region**, the region above the hyoid bone is the floor of the mouth There may be some remains of the decussating fibres of the platysma muscles in the superficial fascia which covers it these should be removed. The deep fascia of the area has already been examined, and there are now to be defined by its removal the following structures (Fig 36) —

1 The **anterior belly of the digastric muscle**, which is attached to the mandible close to the symphysis and descends towards the hyoid bone. Between the muscles of the two sides a few small **submental lymph glands** are to be found they receive the lymph from the anterior part of the tongue and the middle part of the lower lip

2 The anterior part of the **mylo-hyoid muscle**, the chief muscle of the floor of the mouth and on which the digastric lies. Its fibres run towards the middle line and are inserted into a median fibrous raphe which extends from the symphysis to the hyoid bone. The two muscles should be no more than recognised and surface cleaned at the present time

Subdivisions of the Anterior Triangle.—The anterior triangle of the neck is subdivided into three subsidiary parts by the two bellies of the digastric muscle and the anterior belly of the omo-hyoid. These parts and their boundaries, which are now fully displayed, are to be defined they are as follow (Figs. 25 and 36) —

1 The **submandibular triangle** is bounded below by the two bellies of the digastric muscle and above by the lower border of the mandible the posterior belly of the digastric is supplemented by the stylo-hyoid muscle

2. The **carotid triangle**, so named because it contains parts of all three carotid arteries, is bounded behind by the anterior border of the sterno-mastoid, and in front by the posterior belly of the digastric muscle above and the anterior belly of the omo-hyoid below It is of small size in the undissected neck for the sterno-mastoid muscle is held well forwards by its fascial connexions.

3 The **muscular triangle** is limited in front by the middle line of the neck, and is bounded behind by the omo-hyoid muscle above and the sterno-mastoid below its visible contents are the infra hyoid muscles.

In addition to these three triangles on each side of the neck there is a small area above the hyoid bone between the anterior bellies of the digastric muscles which is common to the two sides it is named the **submental triangle.**

The superficial contents of each of these triangles are now to be secured. All of them will be met with in later dissections, when they will be dissected and described at present they are only to be found, recognised, and followed as far as the limits of the triangles permit (Figs. 36 and 37)

Submandibular Triangle.—The submandibular triangle is almost

part of it the submandibular salivary gland which also overlaps its inferior boundary and extends upwards deep to the jaw. Its surface is to be cleaned and the lymph glands related to it chiefly along the lower border of the jaw are to be defined. The anterior facial vein is to be followed across the gland and traced downwards as far as possible it enters the carotid triangle and joins the anterior branch of the posterior facial vein to form the common facial vein (Fig. 7). The

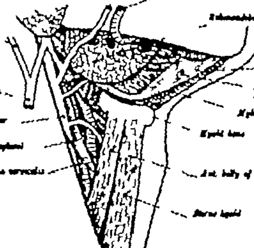


FIG. 36.

Superficial dissection of the anterior triangle of the neck. The sterno-mastoid muscle has been retracted. The arteries and veins are to be coloured and the following structures named: submental artery, mylo-hyoid nerve and artery, hypoglossal nerve, the nerve to the thyro-hyoid, lingual vein, common facial vein, the carotid arteries, superior thyroid artery and vein, and the posterior belly of the digastric muscle.

facial artery is to be dissected as it emerges between the gland and the mandible, and its submental branch is to be secured and traced along the lower border of the bone. The salivary gland is then to be turned upwards and fixed. The mylo-hyoid nerve and artery are to be secured by finding first the branches of them which enter the posterior border of the anterior belly of the digastric muscle and then the main trunks which lie on the mylo-hyoid muscle and sink into its substance. The anterior and posterior bellies of the digastric muscle are to be followed

towards their intermediate tendon which lies above the great cornu of the hyoid bone and it will be observed that this tendon is embraced by the cleft lower end of the **stylo-hyoid muscle** and is fixed to the hyoid bone by a strong fascial band through which it can move. Behind the anterior belly of the digastric the posterior part of the **mylo-hyoid muscle** should be cleaned until its posterior free margin is defined and there will be seen there deep to it part of the **hyo-glossus muscle.** Passing under the posterior border of the mylo-hyoid muscle close to the great cornu of the hyoid bone, there are to be found the **hypoglossal nerve** and immediately below it the **lingual vein** (Fig 36) while deep to the hyo-glossus muscle at the same level and to be exposed for a short distance by cutting through its fibres there is the **lingual artery**

Carotid Triangle.—The carotid triangle is more easily explored if the anterior border of the sterno-mastoid muscle is retracted laterally this should be gently done so as not to break the small arteries which enter its deep surface The lower part of the **internal jugular vein** is to be secured first it lies in the most lateral part of the triangle, under cover of the sterno-mastoid muscle and on its medial side is the **common carotid artery** The artery is to be followed upwards without being cleaned as far as the upper border of the thyroid cartilage at which level it divides into the **external** and **internal carotid arteries** the external artery is antero-medial to the internal artery The **anterior facial vein** is to be followed across the posterior belly of the digastric muscle and its junction with the anterior branch of the **posterior facial vein** below the lower end of the parotid gland is to be defined. The trunk which is formed by the union of these vessels is the **common facial vein** (Fig 36) This vein and the **lingual vein** are to be traced downwards and backwards across the external and internal carotid arteries to their union with the internal jugular vein at or under the anterior border of the sterno-mastoid muscle they may join one another before they enter it. At a lower level, opposite the thyro-hyoid interval, the **superior thyroid vein** or **veins** should be found it joins the common facial vein or enters the internal jugular vein directly (Fig. 36) The **hypoglossal nerve** is then to be followed backwards from the submandibular triangle into the carotid triangle it passes deep to the posterior belly of the digastric and the stylo-hyoid muscle (Fig 37) It then crosses the external and internal carotid arteries and disappears from view between the internal carotid artery and the internal jugular vein and as it does so it gives off its descending branch the **descendens hypoglossi.** This nerve is to be traced downwards in the fascia which covers the arteries until it disappears under cover of the anterior belly of the omo-hyoid muscle It is joined there, from the lateral side by a communicating branch from the second and third cervical nerves, the **descendens cervicalis** (Fig 36) the loop which is formed by the junction of the two nerves being named the **ansa hypoglossi.** The descendens cervicalis usually emerges on the lateral side of the internal jugular vein and runs medially superficial to it and the common carotid artery but sometimes it emerges on its medial

side. In front of its descendens branch and opposite the tip of the great cornu of the hyoid bone, the hypoglossal nerve gives off its **branch to the thyro-hyoid** muscle a slender nerve which should be secured and followed forwards to the muscle

The fascial sheath which surrounds the common carotid artery and the internal jugular vein and is continued upwards round the vein and the internal carotid artery is known as the **carotid sheath** (p. 10 and Fig. 6) it is to be carefully removed and the carotid system

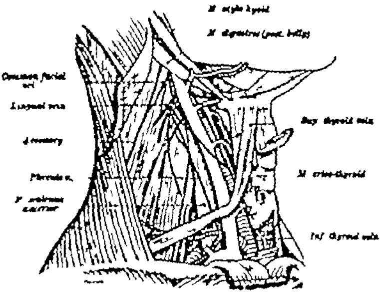


Fig. 37

Deep dissection of the side of the neck. The sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles have been reflected. The arteries and veins and the thyroid gland are to be coloured, and the following structures are to be named the internal jugular vein and the carotid arteries; the subclavian, transverse cervical, and supra-scapular arteries and the subclavian vein; and the hypoglossal nerve descendens hypoglossi, descendens cervicalis, and ansa hypoglossi.

of vessels fully exposed. The **internal and external laryngeal nerves** are to be secured at this stage of the dissection. They are the terminal branches of the **superior laryngeal branch of the vagus nerve** (Fig. 91). The internal nerve will be found in the thyro-hyoid interval behind the posterior border of the thyro-hyoid muscle under which it disappears it is accompanied and covered by the **laryngeal branch of the superior thyroid artery** The external nerve is much smaller in size and more difficult to find it should be sought in its course to the crico-thyroid muscle which it supplies deep to the superior thyroid artery at the level of the thyroid cartilage. The internal jugular vein

is to be separated from the lateral side of the common carotid and internal carotid arteries. In the interval between the vein and the arteries, deep to them and contained within the carotid sheath the **vagus nerve** will readily be found. Numerous **lymph glands**, large and small in size lie on the carotid sheath and at its sides they are the **deep cervical glands**, and those that are found should be retained

The dissector must now proceed to clean and follow out the **branches of the external carotid artery** that lie in the carotid triangle there are five branches to be secured (1) The **superior thyroid artery** arises just below the level of the great cornu of the hyoid bone it runs downwards and medially and disappears under the anterior belly of the omo-hyoid muscle to reach the thyroid gland. It gives off a small infra hyoid branch and then an internal laryngeal branch which runs with the internal laryngeal branch of the superior laryngeal nerve lower down a crico-thyroid branch arises from it and just as it disappears a sterno-mastoid branch is given off which runs along the posterior border of the omo-hyoid and crosses the common carotid artery and the internal jugular vein to reach the muscle (2) The **lingual artery** arises just above the great cornu of the hyoid bone. It first forms a small loop convex upwards and then runs forwards and disappears under the posterior border of the hyo-glossus muscle the loop permits the upward movement of the hyoid bone without tension of the artery The hypoglossal nerve lies superficial to it (Fig 36) It gives off a small supra-hyoid branch which runs forwards superficial to the hyo-glossus muscle (3) The **ascending pharyngeal artery** springs from the deep surface of the commencement of the external carotid artery and ascends on the wall of the pharynx, which forms the floor of the carotid triangle in the interval between the internal and external carotid stems. (4) The **facial artery** arises immediately below the posterior belly of the digastric muscle and, passing forwards, almost at once disappears under cover of it sometimes however it arises at a higher level and then cannot be seen. (5) The **occipital artery** takes origin at the lower border of the posterior belly of the digastric muscle and runs backwards and upwards under cover of it. It crosses the internal carotid artery the internal jugular vein and the accessory nerve It gives off near its origin a sterno-mastoid branch which passes downwards and backwards to the sterno-mastoid muscle the hypoglossal nerve hooks round it from below

The lower end of the parotid gland is then to be pushed upwards and the **accessory** (eleventh cranial) **nerve** secured as it emerges from under cover of the posterior belly of the digastric muscle (Fig 37) It passes (usually) superficial to the internal jugular vein and enters the sterno-mastoid muscle as a rule accompanied by a small artery a second sterno-mastoid branch of the occipital artery

Muscular Triangle.—In the muscular triangle the slender ribbon like **infra-hyoid muscles** are to be examined in detail. They are arranged in two layers, the **omo-hyoid** and the **sterno-hyoid** forming the superficial layer and the **sterno-thyroid** and the **thyro-hyoid** the deep layer They cover the side of the thyroid gland, the trachea the larynx and the

thyro-hyoid membrane (Fig 6) The muscles are concerned in the movement of the larynx and the hyoid bone chiefly in the acts of swallowing and talking acting as depressors of these part after they have been raised with the pharynx They are supplied by branches from the hypoglossal nerve and the ansa hypoglossi which convey to them fibres from the first second and third cervical nerves. The nerves of supply enter the interval between the two layers and sink into the substance of the muscles below their middle parts.

The omo-hyoid muscle consists of two fleshy bellies united by an inter mediate tendon (Fig. 37). The posterior belly was examined in the dissection of the posterior triangle. It was traced under the sterno-mastoid muscle where it ends in the central tendon (p. 89). This tendon is held in position by a strong process of fascia which is ttached below to the sternum and the first costal cartilage The terior belly having crossed the internal jugular vein and the common carotid artery emerges from under the sterno-mastoid and passes almost vertically upwards kee t the lateral border of the sterno-hyoid muscle. It is inserted into the lateral part of the lower border of the hyoid bone The omo-hyoid muscle is one of the most variable in the body The commonest variation is an ttachment to the clavicle which may be the sole origin of the posterior belly or may be a supernumerary head.

The sterno-hyoid muscle arises from the poster'or surface of the medial end of the clavicle, the upper and posterior part of the manubrium sterni, and the capsule of the sterno-clavicular joint It i inserted into the lower border of the body of the hyoid bone. There is sometimes a transverse tendinous inscription in it a short distance bove the sternum. The muscles of the two sides are separated from one another below but about the middle of their course they come close together and from here upwards lie side by side.

The sterno-hyoid is to be divided as low down as possible and turned upwards towards its insertion its nerve of supply from the ansa hypoglossi entering its deep surface should be secured. The two deeper muscles of the infra hyoid group are then to be cleaned and examined, the omo-hyoid being displaced as much as is necessary to define the thyro-hyoid.

The sterno-thyroid is shorter and broader muscle than the sterno-hyoid under cover of which it lies. It arises from the posterior surface of the manubrium sterni lower down than the sterno-hyoid and from the edge of the cartilage of the first rib, and is inserted int the oblique line on the lateral surface of the thyroid cartilage. Occasionally there is an incomplet tendinous intersection about the centre of the muscle. At their origin the muscles of the two sides are in contact, but as they ascend they diverge from one another

The thyro-hyoid is small quadrilateral muscle and appears to be the upward continuation of the sterno-thyroid. It arises from the oblique line on the lateral surface of the thyroid cartilage and is inserted into the lower border of the great cornu of the hyoid bone It covers the lateral part of the thyro-hyoid membrane, and passing under it from behind to pierce the membrane there have already been secured the internal laryngeal nerve and the laryngeal branch of the superior thyroid artery Its nerve is a special branch of the hypoglossal nerve.

The sterno-thyroid muscle is to be divided as low as possible and turned upwards towards its insertion, its nerve from the ansa hypoglossi having been traced to it The thyro-hyoid branch of the hypoglossal nerve is to be followed into the muscle and if the external laryngeal nerve was not found before it should be sought now along the upper edge of the sterno-thyroid muscle It is accompanied there by the crico-thyroid branch of the superior thyroid artery The **lateral lobe of the thyroid gland** is now exposed and below it a part of the side of the **trachea** (Fig 37)

The **sterno-mastoid muscle** is now to be examined. Its surface is to be carefully cleaned from its origin to its insertion and its anterior border sharply defined the parotid gland it will be noted overlaps the anterior border above the angle of the jaw The muscle stretches obliquely along the whole length of the side of the neck and divides it into the anterior and posterior triangles. The following relations of its anterior border are to be carefully noted (1) that it covers the posterior part of the lateral lobe of the thyroid gland (Fig 6 (2) that only a small part of the upper end of the common carotid artery and the lower parts of the internal and external carotid arteries are visible in front of it—the common carotid artery indeed may be entirely concealed (3) the internal jugular vein lies in front of it if at all, only in the upper and posterior angle of the carotid triangle not uncommonly however it is entirely hidden beneath the muscle It is not possible therefore, to examine the course and relations of the great vessels of the neck until the sterno-mastoid muscle has been reflected, or as in an operation on the living subject it is forcibly retracted backwards. Its surface should therefore be cleaned and the external jugular vein and the great auricular and anterior cutaneous nerves turned from it. Into the anterior border of its deep surface there should be followed the sterno-mastoid branch of the superior thyroid artery and the two branches of the occipital artery and just above the upper occipital branch the accessory nerve is to be secured as it passes through the deeper fibres of the muscle. The attachments of the muscle are now to be examined.

The **sterno-mastoid** (sterno-cleido-mastoid) **muscle arises** below *in two* parts, one attached to the anterior surface of the upper part of the manubrium sterni and the other to the upper surface of the medial third of the clavicle. The sternal head is thick and rounded and tendinous on the surface but the clavicular head, separated from the sternal head by a *variable interval, is* flat and composed of more fleshy fibres. The sternal head widens rapidly it crosses the sterno-clavicular joint and overlaps the clavicular head whose fibres are more vertical. The two heads fuse about the middle of the neck and form a thick muscle which extends upwards, laterally and backwards, and is inserted into the anterior surface *of the mastoid process*, a ridge which runs backwards bove its lateral surface, and the lateral half or more of the superior nuchal line of the *occipital bone;* at the insertion the anterior part is thick and tendinous and the remainder thin and poneurotic.

The sterno-mastoid muscle is to be divided close to its origin and turned upwards towards its insertion. The arteries which supply it may be divided as they enter it, but the accessory nerve which is its chief nerve supply is to be dissected from among its fibres It passes through the clavicular head or between the substance of the two heads about the junction of the upper and middle thirds. The muscle is also supplied by a branch from the second cervical nerve.

It is convenient at this stage of the dissection and it also meets the requirements of the dissectors of the arm to remove the clavicle and thus display the structures at the root of the neck This is best done by disarticulating the bone at the sterno-clavicular joint, the structure of which can be studied during the dissection. The fibres of origin of the sterno-mastoid and infra hyoid muscles will require

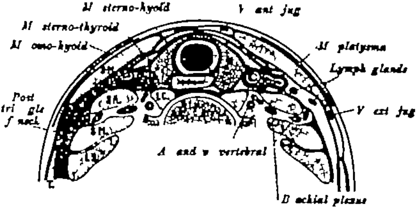


Fig 38.

Diagram of transverse section of the lower part of the neck. On the left side the deep fascia is shown as it exists, continuous mass; on the right side it is resolved into its hief layers. In front f the body of the vertebra and the median part of the pre-vertebral fascia is the oesophagus, and in front of it is the trachea; on each sid in the groove between the viscera are the inferior thyroid artery and the recurrent laryngeal nerve The lobes of the thyroid gland lie at the sides and its isthmus crosses the front of the trachea. The carotid sheath is fused with the pre-tracheal fascia in front and the pre-vertebral fascia behind and lateral to it are the deep cervical lymph glands; and behind it is the sympathetic cord and, more laterally on the surface of the scalenus anterior, the phrenic nerve. (See also Figs. 4 and 6.)

to be removed from both bones and from the fibrous capsule which stretches between them. The capsule is then to be cleaned and, working with the dissectors of the arm the joint is to be dissected and studied as is described in Vol. I p 97

The Deep Cervical Fascia.—The dissector will have noted that under the sterno-mastoid muscle there is considerable amount of loose fascial tissue which surrounds and embeds the structures of the neck it contains the deep lymph vessels of the neck and a large number of lymph glands. Before the glands are dissected and the other structures

cleaned, the dissector should examine with some care a transverse section of the neck to learn the general position and relations of the great vessels and nerves he is about to study and at the same time to understand the arrangement of the fascia and for this purpose Fig 58 should also be used. The general description of deep fascia in Vol. I p 91 is to be read

The deep cervical fascia forms a general investing layer for the neck and surrounds and embeds the various structures which are situated in it It I for the most part a loose fluid-containing, fibro-areolar tissue (see Vol. I) which fills all th intervals between the muscles, vessels, viscera, glands, and nerves, and allows them freely to move on one another; but certain parts of it are more condensed and firmer and in embalmed subjects they form what ppear to be heaths or layers. The more special of these parts are the carotid sheath and the pre-tracheal and pre-vertebral layers and they are clinically important for they tak part in directing the spread of infective processes.

The general investing layer has already been described. As seen on the transverse section it covers the anterior triangles of the neck, and when followed laterally on each side splits to enclose the sterno-mastoid muscle behind the muscle it roofs the posterior triangle and at the anterior border of the trapezius splits again and is conducted along its surfaces to the vertebral spines where it fuses with the ligamentum nuchæ At the upper end of the neck this layer ensheath the submandibular and parotid glands, as will be described later at the root of the neck it was found to split into two layers both in the anterior and posterior triangles. The carotid sheath is a condensation round the common and internal carotid arteries, the internal jugular vein, and the vagus nerve; and these structures are to be regarded as embedded in the tissue rather than as enclosed in a hollow tube. Over the arteries the sheath is thick and strong but over the internal jugular vein it is thin. In front and behind it is fused with the pre tracheal and pre-vertebral layers. The pre-tracheal layer ensheaths the infra-hyoid group of muscles and forms with them a triangular septum in the neck whose apex is at the hyoid bone and the base below In the lower part of the neck it is fused with the deep layer of the investing fascia and with it forms a strong band which binds the tendon of the omo-hyoid t the sternum and the first costal cartilage but it is continued from the neck into the thorax and there fuses with the pericardium. In the neck, beneath the infra hyoid muscles and between the muscles of the two sides, it lies in front of the larynx and trachea and provides a fascial sheath for the thyroid gland and lateral to the muscles it passes in front of the carotid sheath and blends with the fascia on the deep surface of the sterno-mastoid muscle The pre-vertebral layer covers the muscles in front of the vertebral column and on them xtends up t the base of the skull to which it is ttached The fascia ends below in the thoracic region by blending with the anterior ligaments of the vertebral column. Traced laterally in the neck, it passes behind the carotid sheath and covers the scalenus anterior and from it extends onto the muscles in the floor of the posterior triangle, namely the splenius capitis, scalenus medius, and the levator scapulæ Lying on it in the front of the neck re the pharynx and œsophagus; while behind t there are placed the anterior divisions of the cervical nerves, forming the cervical and brachial plexuses, and the subclavian artery It is carried by the brachial plexus and the subclavian artery int the axilla as the axillary sheath.

The structures which lie below the sterno-mastoid muscle are now to be defined and studied It i most convenient to begin with the **anterior primary rami of the cervical nerves** (*Fig 39*) The anterior rami of the third to the eighth nerves are easily f und as they emerge between the muscles attached to the anterior and the posterior tubercles of the transverse processes of the cervical vertebræ, but the first nerve must be left undiscovered at present it will be exposed later It will be noted at once that the second, third and fourth nerves unite to form two loops on the scalenus medius behind the pre-vertebral fascia and if the internal jugular vein is pulled forwards, part of the second nerve will be seen to ascend deep to the vein and in front of the transverse process *of the atlas to join the first nerve. This series of loops is the* **cervical plexus** and towards it there should be traced the **descendens cervicalis**, the **small occipital**, the **great auricular**, and the **supra-clavicular nerves**, and the **anterior cutaneous nerve of the neck**, all of which take origin from the roots of the plexus. The chief branch of the plexus, however is the **phrenic nerve**, which arises mainly from the trunk of the fourth nerve and descends on the surface of the **scalenus anterior** muscle deep to the pre-vertebral layer of the deep cervical fascia It passes below the omo-hyoid muscle and over the subclavian artery into the thorax (*Fig. 37*) and running *parallel with it on its medial side* there is a remarkably constant artery the **ascending cervical** branch of the **inferior thyroid artery**

The **cervical plexus** is formed by the anterior primary rami of the upper four cervical nerves, each of which, except the first, divides into upper and lower branches; the branches unite t form three loops (Fig. 39). The plexus lies opposite the upper four cervical vertebræ, under cover of the posterior border of the sterno-mastoid muscle the first loop being placed between the internal jugular vein and the transverse process of the atlas and the second and third loops on the surface of the scalenus anterior muscle. The first loop is connected to the hypoglossal nerve by a branch which conveys to it the fibres of the descendens hypoglossi and the nerve to the thyro-hyoid; and the trunks of the four nerves receive grey rami communicantes from the superior cervical sympathetic ganglion.

The branches of the cervical plexus are arranged in two groups, superficial and deep. The superficial branches, namely the small occipital and great auricular nerves, the anterior cutaneous nerve of the neck, and the supra-clavicular nerves, have already been dissected and followed to their cutaneous distribution. The deep branches are motor nerves, and most of them run backwards t be distributed to the muscles of the neck, namely the sterno-mastoid and trapezius (directly and through communications with the accessory nerve), the levator scapulæ, the scalene muscles, the anterior intertransverse muscles, and the muscles of the pre-vertebral group (rectus capitis lateralis, rectus capitis anterior longus capitis, and longus colli muscles). Two branches of the deep group, however run downwards and forwards, namely the phrenic nerve and the descendens cervicalis (Fig 37).

The phrenic nerve (Figs. 37 and 39) arises chiefly from the fourth cervical nerv ; it also receives branch from the third nerve (on its medial side) and usually branch from the fifth nerve (on its lateral side). It begins on

the scalenus medius at the level of the upper border of the thyroid cartilage but almost at once passes onto the anterior surface of the scalenus anterior and descends on it under the pre-vertebral fascia, obliquely from the lateral to the medial side It is crossed in its course by the posterior belly of the omo-hyoid and the transverse cervical and supra scapular arteries, and is usually overlapped by the internal jugular vein The nerves of both sides are carried over the second part of the subclavian artery on the medial part of the scalenus anterior though the left nerve may leave the muscle at a higher

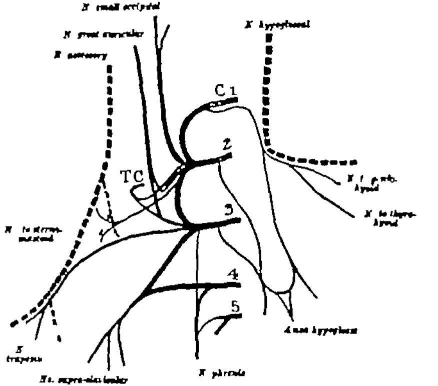


FIG. 30

Diagram of the cervical plexus. It is t be noted that the ansa hypoglossi is formed by fibres of the cervical plexus.

T C., anterior cutaneous nerve of the neck.

level and cross the first part of the artery below the artery the nerves enter the thorax, the relations on the two sides being different. The right nerve leaves the medial border of the scalenus anterior below the subclavian artery and, resting on the cervical pleura, passes behind the terminal part of the subclavian vein In about 5 per cent of subjects, however it passes in front of the vein. It then inclines medially and forwards, crossing either in front of or behind the internal mammary artery (a branch of the first part of the subclavian artery Fig 41), and enters the thorax on the lateral surface of the right innominate vein. The left nerve is crossed just bove the subclavian artery by the thoracic duct (which curves downwards on its lateral side

superficial to the transverse cervical and supra-scapular arteries, and is to be secured now). It is carried over the subclavian artery on the scalenus anterior in the majority of subjects. Below the artery it turns abruptly medially leaves the medial border of the muscle, and, resting on the cervical pleura, passes behind the beginning of the left innominat vein; very occasionally it runs in front of the terminal part of the subclavian vein. It then inclines medially and forwards, crossing either in front of or behind the internal mammary artery and enters the thorax behind the left innominate vein.

The phrenic nerve is the main motor nerve of the diaphragm, which is therefore paralysed by its section. It also contains sensory fibres (about one-third of its total number) which are distributed to the parietal pleura, the fibrous pericardium and its serous lining, and the parietal peritoneum of the upper part of the abdomen. It is joined at the root of the neck by a branch from the middle or inferior cervical sympathetic ganglion.

Accessory phrenic nerve.—The branch of the phrenic nerve from the fifth cervical nerve in about 60 per cent. of subjects descends into the thorax as a separate nerve and joins the main nerve there. It is then known as the accessory phrenic nerve. It lies on the lateral side of the main nerve, usually crosses the third part of the subclavian artery and in about half the number of subjects in which it is present passes in front of the subclavian vein; in these subjects it arises in common with the nerve to the subclavius muscle and appears as a branch of it in the subclavian triangle.

The **descendens cervicalis** arises by two filaments from the second and third cervical nerves (Fig. 30). It passes downwards usually on the lateral side of the internal jugular vein and crossing in front of the vein little below the middle of the neck joins the descendens hypoglossi in front of the sheath of the carotid artery and forms the loop named the ansa hypoglossi. The fibres which run in the descendens hypoglossi, and also those which pass to the thyro-hyoid and genio-hyoid muscles, are derived from the first cervical nerve; the infra-hyoid muscles, therefore, are innervated from the cervical plexus (Fig. 39).

The **brachial plexus** is now to be reviewed. It is dissected by the dissectors of the arm for it gives rise to the nerves of the arm and the dissectors of the head and neck are to assist. The plexus is formed by the anterior primary rami of the fifth, sixth, seventh and eighth cervical nerves and the greater part of the first thoracic nerve and there is usually a communication from the fourth cervical nerve and sometimes a filament from the second thoracic nerve. The cervical nerves appear in the interval between the scalenus anterior and medius muscles while the first thoracic nerve ascends obliquely in front of the neck of the first rib These nerves are named the **roots of the plexus**. They proceed laterally in the lower part of the posterior triangle of the neck, joining with one another and subdividing gain in a remarkably constant manner and, so formed, the plexus passes behind the clavicle into the axilla and terminates in the large nerves of the arm (see Vol. I p 93)

The roots of the brachial plexus ppear in the lower part of the posterior triangle of the neck at the lateral edge of the scalenus anterior and opposite the lower third of the posterior border of the sterno-mastoid. When

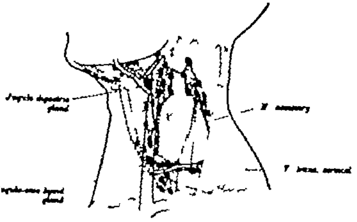
traced laterally they join with one another to form the trunks of the plexus. The fifth and sixth nerves join to form an upper trunk the seventh continues distally as a middle trunk; while the eighth cervical and first thoracic nerves join to form a lower trunk The trunks lie on the surface f the scalenus medius muscle above the third part of the subclavian artery the lowest of them resting on the first rib behind the artery; they are crossed by the posterior belly of the omo-hyoid muscle and the transverse cervical and supra-scapular arteries. The upper trunk is the shortest (see Vol. I p. 95) Each of the three trunks spl t into n anterior and a posterior division, and these re-unite about the lev l of the horizontal clavicle, to form the three cords of the plexus which enter the axilla more or less on the lateral sid of the first part of the axillary artery The three posterior divisions unite to form the posterior cord and of the anterior divisions the upper two unit to form the lateral cord while the lowest anterior division continues distally by itself as the medial cord. From these cords the terminal branches of the plexus arise and will be dissected by the dissectors of the arm

There are some branches, however which arise from the cervical (or supra-clavicular) part of the plexus and are to be dissected by the dissectors of the head and neck; they are distributed to the muscles of the girdle of the limb. (1) The long thoracic nerve arises from the posterior surface of the upper roots of the plexus by three branches. The upper two of them, one from the fifth and one from the sixth cervical nerve, pierce the scalenus medius muscle and unite to form one stem, but the lowest branch, from the seventh cervical nerve passes over the surface of the muscle. The two parts of the nerve descend behind the brachial plexus and the first part of the axillary artery and reach the surface of the serratus anterior muscle on which they unite the nerve passes downward on the surface of the muscle and supplies it (2) The nerve to the rhomboids arises from the lateral border of the fifth cervical nerve and pierces the scalenus medius muscle. In the posterior triangle of the neck it lies above the brachial plexus. It then disappears under the anterior border of the levator scapulae muscle to reach its distribution on the back. (3) The supra-scapular nerve arises from the upper trunk (see Vol. I. p. 95) It runs downwards and backwards on the scalenus medius immediately above the brachial plexus and under cover of the posterior belly of the omo-hyoid (Fig 35) and at the posterior angle of the subclavian triangle it meets the supra-scapular artery and descends with it to supply the supraspinatus and infraspinatus muscles and the shoulder joint. (4) The nerve to the subclavius muscle arises from the anterior surface of the upper trunk, and passes downwards in front of the brachial plexus and the third part of the subclavian artery and deep to the omo-hyoid muscle and the transverse cervical and supra-scapular vessels (Fig. 35) It enters the deep surface f the subclavius muscle. It has already been described to give a branch to the phrenic nerve in many subjects.

In addition to these branches there are small twigs which arise from the nerve roots to supply the scalene muscles and the lower parts of the cervical pre-vertebral muscles. They will be secured later Each root of the plexus is joined by a grey ramus communicans from the cervical sympathetic cord which convey to it sympathetic fibres for the supply of the blood vessels and glands of the limb.

The student has already studied the groups of lymph glands situated at or near the junction of the head and neck and forming there a peri-cervical circle" they are the occipital, mastoid, parotid,

submandibular and submental glands, and they drain the superficial parts of the head and some of the deeper parts of the face (Fig. 21) The remaining deep parts of the face are drained by the retro-pharyngeal glands, situated behind the pharynx in and in front of the pre-vertebral fascia. The efferent vessels from the peri-cervical groups and the retro-pharyngeal glands pass to the cervical glands, which lie in chains along the anterior external, and internal jugular veins and the trachea. The glands on the anterior jugular vein are few in number and small in size they drain the neighbouring skin and muscles and sometimes receive lymph from the thyroid gland. The glands along the upper part of the external jugular vein form the superficial cervical group they have already been studied (p. 61) The glands on the internal jugular vein and the trachea are the **deep cervical glands** some of them,



F 44

The deep cervical glands The sterno mastoid, omo-hyoid, digastric, and trapezius muscles are stippled.

t le t will ha e been seen lying on nd lateral to the carotid sheath. Th v f great linical mportance for they receive the lymph vessels fr m ll part f the head nd neck either directly or through the the gland groups nd at th st ge f the l ssection they should be ex mined a th oughl y ssibl They diminish in size with ag ll lymph glan l d and those f und in an ordinary dissection by no mean rep esent the n rmal number f them further there re many ry small gl nd mong the l mph hannel which connect the larger glan l nd in lise se the may greatly nlarge

The deep cervical lymph glands Fig 44 re merous and some of them are of large size The f rm broad connected hain along the carotid sheath under the sterno-mastoid m scle from the posterior belly of the digastric t the root of the neck the gland lie front behind, and t the sides of the sheath, and many of them be thus in lose contact with the internal

jugular vein. They also extend in two groups from under the sterno-mastoid into the posterior triangle of the neck, namely one group along the accessory nerve as far as the deep surface of the trapezius (p. 94), and one group along the transverse cervical vessels in the lower part of the triangle (p. 9*). The following special glands, or sub-groups of glands, are to be noted: (1) The **jugulo-digastric or tonsillar gland** lies in the angle between the common facial and internal jugular veins it is constant in position. It receives lymph vessels directly from the tonsil, and is early involved in tubercular disease (2) The **jugulo-omohyoid or lingual gland** lies on or just above the tendon of the omo-hyoid muscle; it receives lymph vessels directly and indirectly from the tongue. (3) The **para-tracheal glands** lie along the front and sides of the trachea, especially along the inferior thyroid veins and the recurrent laryngeal nerves some of them are embedded in the back of the lateral lobe of the thyroid gland. These glands form a continuous chain with the tracheal glands in the thorax.

The lower part of the deep cervical chain, having received the efferent vessels of all the higher groups, gives rise to the **jugular lymph trunk**; the right trunk usually joins the right lymph duct which opens into the angle of union of the subclavian and internal jugular veins or into one of them, and the left trunk either joins the thoracic duct or opens directly into the internal jugular or the innominate vein.

The student must now proceed to study the **common carotid artery** The fascial sheath around the artery and the thinner layer which invests the accompanying **internal jugular vein** are to be completely removed and behind and between the vessels the **vagus nerve** is to be secured. On the right side the nerve is to be followed downwards till it crosses the anterior surface of the first part of the **subclavian artery** at which point its **recurrent** (or inferior) **laryngeal branch**, which hooks round the vessel, is to be secured On the left side the vagus nerve descends medial to the subclavian artery and on a plane anterior to it At the root of the neck the vagus nerve gives off its **inferior cervical cardiac branch**, a slender filament which is easily broken the right branch passes deep to the subclavian artery and the left branch with the trunk of the vagus into the thorax. (That the parts at the root of the neck may be more easily dissected, it is advisable now completely to remove the lower parts of the sterno-hyoid and sterno-thyroid muscles.) Behind the common carotid artery and covered by the pre-vertebral fascia the dissector must isolate and carefully clean the cervical part of the **sympathetic trunk**. It is to be followed upwards till the lower part of the **superior cervical ganglion** is reached and downwards till it is crossed, either anteriorly or posteriorly at the level of the cricoid cartilage by the **inferior thyroid artery** here the small **middle cervical ganglion** may be found on it. The common carotid artery should then be displaced laterally to expose the side of the **trachea** and the lateral margin of the **oesophagus** and in the angle between these structures there is easily secured the **recurrent** (inferior) **laryngeal branch** of the vagus nerve. It is to be followed upwards until it disappears below the lateral lobe of the thyroid gland in company with the inferior thyroid artery On the left side of the body the student must seek the

sympathetic trunk lies lengthwise directly behind it and the vagus nerve is postero-lateral to it. The inferior thyroid artery passes medially behind the artery at the level of the cricoid cartilage while the vertebral artery intervenes between it and the transverse process of the seventh cervical vertebra. On the right side the recurrent branch of the vagus nerve passes behind it while on the left side the thoracic duct runs laterally between it in front and the vertebral artery behind. (3) On the medial side of the artery lie the larynx and pharynx and lower down the trachea and oesophagus and, in the interval between them, the recurrent laryngeal nerve. The lateral lobe of the thyroid gland lies on the medial side of the artery but very frequently it also forms a direct anterior relation. (4) On the lateral side there is the internal jugular vein which accompanies the artery in its whole length.

The student must now complete the study of the **subclavian arteries** the third parts of them were examined in the subclavian triangles. At their commencement they lie deeply in the root of the neck and especially on the left side are considerably hidden by the large veins related to them. It is advisable therefore to cut across the internal jugular vein at its lower part after having tied it with two ligatures; it can then be drawn well aside and on the removal of some areolo-fatty tissue the first part of the subclavian artery will be exposed. The **vertebral vein** which lies behind the internal jugular vein, and the **thoracic and right lymph ducts** are to be preserved intact. In relation to the anterior surface of the subclavian artery there are to be secured the **vagus nerve** and a loop of the **sympathetic trunk** named the **ansa subclavia** (Vieussens). The sympathetic trunk itself is to be isolated behind the common carotid artery and its **inferior cervical ganglion** sought in the interval between the neck of the first rib and the transverse process of the seventh cervical vertebra. The **lower trunk of the brachial plexus** is then to be traced medially and the nerves roots which form it (C 8 and T 1) are to be defined. The branches of the first part of the subclavian artery are to be cleaned namely the **internal mammary vertebral, and thyro-cervical arteries.**

The **subclavian arteries** arise differently on the two sides of the body: the artery of the right side commences at the bifurcation of the innominate artery behind the sterno-clavicular joint while that of the left side arises directly from the arch of the aorta. On each side the vessel enters the neck behind the sterno-clavicular joint and pursues an arched course across the root of the neck (Fig 41). It rests behind on the anterior surface of the dome of the pleura a short distance below its summit, and is separated by it from the apex of the lung and then crosses the upper surface of the first rib and at the lateral margin of the rib it becomes the **axillary artery**. In its course the subclavian artery passes posterior to the scalenus anterior muscle and is conveniently divided into three parts by its relation to it: the first part extends from the origin of the vessel to the medial border of the *muscle*, the second part lies behind the muscle and the third part *extends from* the lateral border of the muscle to the lateral border of the first rib (Fig 41). The relations of the first part are a little different on the two sides on

account of the difference in origin but the relations of the second and third parts are in the main the same on the two sides.

The first part of the subclavian artery is placed deeply lying under cover of three muscular layers, namely the sterno-thyroid, sterno-hyoid, and sterno-mastoid muscles, as well as the superficial fascial structures which cover them. It extends from behind the sterno-clavicular joint obliquely upwards and laterally across the root of the neck, and at its termination at the medial border of the scalenus anterior has reached a point half an inch above the

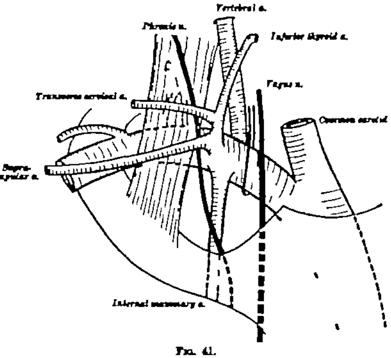


FIG. 41.

Diagram of the right subclavian artery and its branches. The scalenus anterior muscle crosses the artery and divides it into three parts. The ansa subclavia crosses the first part close to the vagus; arising from the second part is the costo-cervical artery; and from the third part there not uncommonly arises the descending scapular artery. The phrenic nerve is shown displaced medially as it usually is after dissection. The student is to colour the arteries and himself insert the subclavian and internal jugular veins.

clavicle; the left artery, in continuation of its thoracic course, is more vertical than the right artery. It is crossed by the internal jugular and vertebral veins, and also by the anterior jugular vein, which, however, is separated from it by the infra-hyoid muscles; and the common carotid artery lies in front of its commencement. The vagus nerve lies anterior to it and the ansa subclavia encircles it, while the cardiac branches of the vagus and the cervical sympathetic trunk descend behind, or sometimes in front of, it. On the left side these veins and nerves are placed more or less parallel to the artery owing to its almost vertical direction, lying in front of it on its medial side; on the right

side they cross the vessel. The peculiar relations of the two sides are that on the right side the recurrent branch of the vagus, given off from it medial side, hooks round the lower border of the artery and ascends medialwards behind it, while it is crossed in front by the right lymph duct the left recurrent nerve hooks round the arch of the aorta and ascends on the medial side of the subclavian artery On the left side the left innominate vein lies in front of the artery and the thoracic duct arches over it On both sides the artery rests behind and below on the dome of the pleura, separated from it by a thin fibrous sheet, the supra pleural membrane (Sibson's fascia); it is in close apposition, through the fascia, with the apex of the lung and lodges in a groove on its anterior surface (see Vol. II).

The second part of the artery forms the summit of its arch It may rise as much as an inch above the clavicle It has the same relations on th two sides of the body It lies behind the scalenus anterior muscle which itself is covered by the clavicular origin of the sterno-mastoid muscle and the cervical fascia It rests behind on the dome of the pleura, and the supra-pleural membrane a little below its summit and on a small part of the scalenus medius muscle; and the part of the first thoracic nerve which joins the brachial plexus ascends behind it The subclavian vein is below the artery and is separated from it by the scalenus anterior The phrenic nerve is usually carried over the artery on the surface of the scalenus anterior muscle

The third part of the artery was dissected and described in the posterior triangle of the neck (Fig 3? and p 91).

The **branches of the subclavian artery** are four in number Three of them the **vertebral**, the **thyro-cervical**, and the **internal mammary artery** take origin from the first part and one the **costo-cervical artery** arises from the second part. In a large number of subjects however a branch of considerable size will be found ari ing from the third part most frequently this is the **descending scapular artery** arising directly from the subclavian instead of as is more common, from its thyro-cervical branch but sometimes it is the **supra-scapular artery** The branches are to be followed out as far as is possible in the present dissection (Fig 41)

The vertebral artery (Fig 7), the first branch of the subclavian artery is seen in only a small part of its course. It arises from the posterior part of the upper border f the subclavian trunk (though occasionally on the left side it arises directly from the aorta), and runs upwards in front of the transverse process of the seventh cervical vertebra in the interval between the scalenus anterior and the longus colli muscles (first part) It enters the foramen in the transverse process of the sixth cervical vertebra, and passes through the foramina of all the vertebræ above (second part, p. 17); and in the sub-occipital triangle (third part, p. 84) it winds medially to enter the foramen magnum, and in the skull it supplies the brain (fourth part, p. 17). Its first part is about two inches in length, that is between its origin and the point at which it enters the foramen in the transverse process of th sixth vert bra. It is deeply placed. In front of it there are the inferior thyroid artery the middle cervical ganglion, the common carotid artery and the vertebral veins; and on the left side there is also the thoracic duct The cervical sympathetic trunk lies on its medial side, and the inferior cervical ganglion, which is partly behind it, gives off branches which form a plexus

round it. The seventh and eighth cervical nerves pass laterally behind it. (The artery sometimes enters the foramen of a higher vertebra than the sixth, most commonly that of the fourth.)

The vertebral vein, a rule smaller than the artery emerges from the foramen in the sixth vertebra and passes downwards in front and on the lateral side of the artery. It lies behind the internal jugular vein, and near its termination crosses the subclavian artery to open into the commencement of the innominate vein. The thoracic duct sometimes passes between it and the vertebral artery. It receives the deep cervical vein (p. 5) and the anterior vertebral vein (see below). (Sometimes it escapes through the foramen in the transverse process of a vertebra other than the sixth.)

The **internal mammary artery** arises from the lower part of the anterior surface of the subclavian artery directly below the origin of the thyro-cervical artery and descends behind the clavicle and the first costal cartilage into the thorax where it is distributed (Fig. 41). It lies on the surface of the cervical pleura and passes behind the medial end of the subclavian vein; and it is crossed there from the lateral side by the phrenic nerve. The **venae comites** which accompany the artery join the innominate vein at the inlet of the thorax; the artery is therefore not accompanied by a vein in the neck.

The **thyro-cervical artery** is a short thick trunk which arises from the anterior surface of the subclavian artery close to the medial border of the scalenus anterior muscle under cover of the internal jugular vein. It lies between the phrenic and vagus nerves. It divides almost immediately into three branches, the **inferior thyroid, transverse cervical, and supra-scapular arteries** (Fig. 41).

The **inferior thyroid artery** first runs upwards, lying behind the internal jugular vein and on the lateral side of the vertebral artery. At the level of the cricoid cartilage it bends medially passes across the vertebral artery and behind the vagus, the sympathetic trunk, and the common carotid artery and descends along the posterior border of the lower half of the thyroid gland; the middle cervical sympathetic ganglion usually rests on the summit of the curve. The recurrent laryngeal nerve runs upwards generally in front of the terminal part of the artery but as a rule lies behind, or among, its glandular branches. The branches to the thyroid gland, one of which ascends along the posterior border of its lateral lobe supply the lower and posterior parts of the lateral lobe. The artery gives off in addition oesophageal and tracheal twigs, a small inferior laryngeal branch which accompanies the recurrent laryngeal nerve to the larynx, and from the summit of its loop the **ascending cervical artery**. This is a remarkably constant branch which runs upwards on the transverse processes of the cervical vertebrae in the interval between the scalenus anterior and longus capitis muscles. It gives twigs to the muscles and small branches pass from it into the vertebral canal along the spinal nerves.

The **inferior thyroid veins** are large vessels which issue from the lateral lobes of the thyroid gland and pass downwards in front of the trachea. They communicate freely with one another almost forming a plexus below the isthmus of the gland, and open below into the innominate veins; sometimes, however the two veins unite to form a common trunk which enters either the left or the right innominate vein. The **anterior vertebral vein** accompanies the ascending cervical artery; it opens into the vertebral vein as it issues from the foramen in the sixth cervical transverse process.

The transverse cervical and supra-scapular arteries run laterally in front of the scalenus anterior muscle and the phrenic nerve and in the posterior triangle of the neck they cross the brachial plexus (Fig 33) The supra-scapular artery lies behind the clavicle and the transverse cervical artery at a higher level The latter vessel is frequently of small size or altogether wanting, and it, or one of its terminal branches (the superficial cervical and descending scapular arteries) then arises from the third part of the subclavian artery (Fig 41). This aberrant vessel is most frequently the posterior scapular artery and as a rule it threads its way backward among the trunks of the brachial plexus. The veins accompanying the arteries were dissected in the posterior triangle of the neck; they end in the external jugular vein (Fig. 33).

The costo-cervical artery arises from the upper and posterior surface of the second part of the subclavian artery close to the medial margin of the scalenus anterior muscle (Fig 41); on the left side however it very often springs from the first part. It runs upwards and backwards over the dome of the pleura to the front of the neck of the first rib and divides there into two branches. The deep cervical branch passes backwards between the neck of the first rib and the transverse process of the seventh cervical vertebra, and is distributed among the muscles of the back of the neck, where it was dissected (p 75). The superior intercostal branch descends behind the pleura in front of the necks of the first and second ribs and is distributed in the upper two intercostal spaces after the manner of a posterior intercostal artery (Vol. II). The deep cervical vein is a large vessel (p. 5) It ends in the vertebral vein.

The course and relations of the subclavian vein are now easily followed and after they have been considered the vein is to be inserted in Fig 41 by the student himself. It commences at the outer border of the first rib as the continuation of the axillary vein and it arches over the root of the neck wholly behind the clavicle. In its whole course it lies anterior to and below the level of the third and second parts of its companion artery It is placed first on a shallow groove on the upper surface of the first rib and then in front of the scalenus anterior muscle and at the medial margin of this muscle, while it lies in front of the cervical pleura it joins the internal jugular vein to form the innominate vein. The external jugular vein its only constant tributary terminates in it at the lateral border of the scalenus muscle The thoracic duct opens into the left vein, and the right lymph duct into the right vein, at its junction with the internal jugular vein. The subclavian vein has one valve placed distal to the entrance of the external jugular vein it is the most proximal valve on the venous system of the arm (Fig 42)

The terminal part of the thoracic duct will be seen, if a careful dissection has been made, rising into the root of the neck along the left margin of the oesophagus. It is a small thin-walled vessel, often mistaken for fascia and sometimes for a vein for it often contains a reflux of blood, but, at least when full, it is constricted at intervals and has a beaded appearance. At the level of the seventh cervical vertebra it arches laterally and anteriorly above the level of the pleura and the subclavian artery and passes between the carotid sheath and its contents in front and the vertebral, inferior thyroid, and

behind the medial third of the clavicle Posteriorly in most subjects, the pleura rises only as high as the neck of the rib but in front it rises above the anterior part of the rib for a distance which varies between one and two inches the differences depend on differences in obliquity of the thoracic inlet The cervical pleura is covered and strengthened by a fascial expansion the **supra-pleural membrane** (Sibson's fascia) which is attached above to the transverse process of the seventh cervical vertebra and below to the medial margin of the first rib and in addition it is supported antero-laterally by the scalenus anterior and medius muscles In relation to its anterior surface for part of their course there have been dissected (1) the subclavian artery and its branches (2) the vertebral, subclavian and innominate veins and (3) the vagus and phrenic nerves and on the right side, the recurrent laryngeal nerve.

DEEP DISSECTION OF THE FACE

The student must now leave the dissection of the neck and carry out a deep dissection of the face for only after this is completed can he examine the course and relations of the upper parts of the great vessels and nerves of the neck The neck is to be wrapped in cloths kept moist with preserving fluid. The regions of the face to be dissected are the **parotid region,** the **temporal and infra-temporal** (pterygoid) **regions,** and the **submandibular** (supra hyoid) **region,** and the chief structures to be examined are those of the masticatory apparatus (p. 13).

The Parotid Region

The **parotid gland,** the largest of the salivary glands, is the chief structure to be dissected in the parotid region. It has an irregular shape in conformity with the irregular space in which it lies but if it is examined on a transverse section (Fig 43) it is seen to be a more or less wedge-shaped body the base of the wedge being the superficial surface and to fill a more or less triangular space the parotid space, which is bounded in front by the ramus of the mandible and the muscles related to it and behind by the mastoid and styloid processes and the muscles attached to them. The space extends upwards to the external auditory meatus and downwards into the carotid triangle of the neck for the gland descends below the angle of the mandible The gland is thus best described to have three surfaces namely a **superficial surface** which is at present exposed an **antero-medial surface** facing forwards, and a **postero-medial surface** directed backwards and medially

The gland is enclosed in a sheath of fascia the **parotid sheath,** prolonged upwards from the investing layer of the neck and continuous in front and behind with the fasciae on the masseter and sterno-mastoid muscles it sends septa into the gland substance The covering of the superficial surface is dense and offers a strong resistance to swelling of the gland or of the lymph glands contained in it The covering of the deep surfaces is much thinner except for a thickening of its antero-

inferior edge which stretches between the styloid process and the angle of the mandible and forms the **stylo-mandibular ligament** this ligament intervenes between the parotid and submandibular glands.

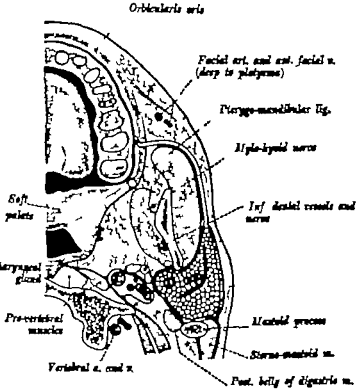


FIG. 43.

Diagram of transverse section of the head at the level of the parotid gland. The relations of the structures shown are to be carefully studied. The buccinator and the superior constrictor muscle of the pharynx, covered with the bucco-pharyngeal fascia, arise from the pterygo-mandibular ligament; on the constrictor ar the ascending pharyngeal vessels and behind it are the retro-pharyngeal glands and the pre-vertebral fascia covering the pre-vertebral muscles. The internal carotid artery and the internal jugular vein are in the carotid sheath, and with them are the glosso-pharyngeal, vagus, and accessory nerves. The styloid process and the muscles attached to it are antero-lateral to the carotid sheath. In the substance of the parotid gland there are, from without inwards, the facial nerve the posterior facial vein, and the external carotid artery The vert bra divided is the tlas

The superficial surface of the gland is to be cleaned of its covering that its relations may be xamined.

The superficial surface of the parotid gland (Figs. 43 and 44) is nearly flat. It is covered by the sk and the superficial and deep fasciæ the deep fascia being continued upwards over t as a dense capsular layer to be

attached to the zygomatic arch. Its lower part is also overlaid by the platysma and risorius muscles. The surface is irregular in outline but, generally speaking, is triangular in form. The blunted apex is below and is wedged between the angle of the mandible and the anterior border of the sterno-mastoid and overlies the posterior belly of the digastric muscle. It is usually in contact with the upper deep cervical lymph glands and entering its deep surface above the upper border of the digastric, is the terminal part of the external carotid artery which, immediately before, gives off its posterior auricular branch; emerging from it are the cervical branch of the facial nerve (for the platysma muscle) and the posterior facial vein usually divided into its anterior and posterior branches. The upper border is the margin of the upper concave surface of the gland which is applied to the floor and anterior wall of the cartilaginous and bony part of the external auditory meatus, as will be seen if the upper part of the gland is everted. Its anterior part lies between the meatus and the back of the temporo-mandibular joint, and if it is turned downwards a process of the gland will usually be seen to pass medially into the glenoid fossa behind the condyle of the mandible; it is this part especially which is affected by the movement of the jaw and if the gland is inflamed then gives rise to considerable pain. The auriculo-temporal nerve emerges from this part of the gland, and pain of an inflamed gland is most commonly referred along it and it is accompanied by the superficial temporal artery and vein and the temporal branches of the facial nerve. The posterior border lies on the mastoid process and below it overlies the anterior border of the sterno-mastoid; passing over it are the facial branches of the great auricular nerve some of which dip into the substance of the gland. The anterior border lies on the back part of the masseter muscle and is prolonged on it as a pointed process from which the parotid duct emerges; above the duct there is usually a small detached accessory parotid gland (socia parotidis). There emerge from below this border the transverse facial artery and the facial branches of the facial nerve.

The parotid duct (Stenson's duct) issues from the anterior facial process of the gland and runs transversely across the masseter muscle half an inch below the zygomatic arch. Its course is indicated by the middle part of a line from the lower margin of the concha of the ear to a point midway between the ala of the nose and the red margin of the upper lip. The transverse facial artery lies above it and the buccal branches of the facial nerve lie below it. At the anterior border of the masseter the duct bends at right angles and traversing the buccal pad of fat pierces the buccinator muscle and its covering fascia; it then passes forward for about a quarter of an inch between the muscle and the mucous membrane of the cheek and opens into the mouth on a small papilla opposite the second molar tooth of the upper jaw (Fig. 43). The duct is about two and one quarter inches long and has thick walls; the lumen is narrowest at the orifice. The duct of the accessory parotid gland opens into it.

The parotid lymph glands (p. 40) are in two sets. (1) There are a few small glands superficial to the deep fascia in front of the tragus of the ear and (2) there are glands partly or wholly embedded in the substance of the gland, chiefly near its superficial surface and others between it and the side wall of the pharynx. The superficial glands drain the side of the scalp, part of the auricle and some superficial parts of the face (Fig. 21); the deep glands drain the external auditory meatus, the parts of the middle ear, the nose, and the palate. Both sets drain into the upper deep cervical glands.

It is difficult to remove the parotid gland entire without damaging the structures which are related to it It is, therefore to be picked away in small pieces and, as this is carried out, the structures which pass through it are to be examined and those which form the relations of its anterior and posterior surfaces are to be defined The parotid duct is to be cut and the great auricular nerve removed. The margins of the gland are to be everted as much as possible so that the deep extension of the gland into the parotid space may be appreciated. The facial nerve and its branches are the most superficial structures in the substance of the gland (Fig. 43) The terminal branches of the nerve, already dissected on the face where they supply the facial muscles,

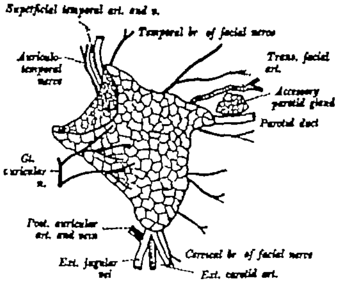


FIG 44
The superficial surface of the parotid gland.

are to be traced back into the gland there they will be found to arise from two main divisions, and these when followed backwards over the posterior facial vein form the trunk of the nerve. The trunk is to be followed backwards over the root of the styloid process to the stylo-mastoid foramen, through which the nerve issues from the skull and there are to be secured arising from it the **posterior auricular nerve and the nerve to the stylo-hyoid and the posterior belly of the digastric muscle.**

The facial nerve leaves the skull through the stylo-mastoid foramen and there lies one to one and half inches deep to the anterior edge of the mastoid process; in the infant, before the mastoid process is developed, the nerve is almost subcutaneous at its exit and is in danger in incisions in

this region. It curves round the lateral side of the internal jugular vein and the root of the styloid process and almost at once sinks into the postero-medial surface of the parotid gland (Fig 43); before entering the gland it gives off the posterior auricular nerve (p. 55) and a branch which divides to supply the stylo-hyoid and the posterior belly of the digastric muscle In the gland the nerve runs downwards and forwards towards the angle of the jaw; it receives communications from the great auricular and auriculo-temporal nerves and divides int two divisions, the upper of which ascends sharply and the lower continues the course of the main trunk. The two divisions give off the secondary sets of branches which pass forwards, usually superficial to the posterior facial vein; and radiating from one another they emerge from th antero-medial surface at the margin of the gland and are distributed in the temple, the face and the neck to the muscles of expression.

As the trunk of the facial nerve is being followed the **posterior auricular artery** will be exposed along the upper border of the digastric muscle. It arises from the external carotid artery just below the parotid gland and passes backwards either superficial or deep to the posterior auricular nerve into the groove at the back of the auricle (p. 58) The **posterior facial vein** lies deeper than the facial nerve in the substance of the gland (Fig 43) It is formed in the gland by the junction of the superficial temporal and maxillary veins, the former vein having received the transverse facial vein. At the lower end of the gland it divides into anterior and posterior branches the anterior branch joins the anterior facial vein to form the common facial vein and the posterior branch unites with the posterior auricular vein to form the external jugular vein (Fig 7) Still deeper than the veins there will be found the upper end of the **external carotid artery** it enters the lower part of the postero-medial surface of the gland and ascends in it to the level of the neck of the mandible where it divides into its terminal branches, the superficial temporal and maxillary arteries. The superficial temporal artery gives off the transverse facial artery The deepest parts of the gland are to be picked away until the styloid process and the origin of the stylo-hyoid muscle are exposed and the posterior belly of the digastric can be followed to its origin on the mastoid process. The **internal jugular vein** and the **internal carotid artery** are to be brought into view as they pass under the posterior belly of the digastric muscle and crossing them the **occipital artery** is to be cleaned as it runs upwards and backwards along the lower border of the digastric. The **accessory nerve** is also to be secured it emerges from below the digastric muscle having crossed either superficial or deep to the internal jugular vein.

The relations of the antero-medial and postero-medial surfaces of the parotid gland are now defined and are to be examined (Fig 43)

The **antero-medial surface** rests against the posterior border of the ramus of the mandible and the internal pterygoid muscl which lies on its deep surface; a short process of the gland, the pterygoid lobe, xtends forwards between these two structures. More superficially the gland rest on the surface of the masseter muscle and is prolonged over it for some distance. This

surface is pierced by the terminal branches of the facial nerve passing onto the face and the maxillary and transverse facial arteries and veins.

The **postero-medial surface** rests against the anterior surface of the mastoid process and the anterior border of the sterno-mastoid muscle. Medial to this it rests on the posterior belly of the digastric and the stylo-hyoid muscle, and still more medially its upper part lies on the styloid process. Below the digastric muscle the gland rests on the internal jugular vein and the internal carotid artery but the upper parts of these vessels and the last four cranial nerves are separated from it by the digastric muscle and the styloid process and the muscles attached to it. The most medial part of the gland lies close to the wall of the pharynx.

The Temporal and Infra-temporal Regions

The dissection of the temporal and infra temporal (pterygoid) regions is essentially a dissection of the **muscles of mastication** (see p. 7) and the **temporo-mandibular joint** at which they act. It also includes the dissection of the vessels and nerves related to and supplying them, namely the **maxillary artery** and **vein** and the **mandibular** (third) **division of the trigeminal** (*fifth cranial*) nerve and their branches.

The student should first study these regions on an articulated skull and become specially familiar with (1) the **upper and lower temporal lines** (p. 22) which bound the **temporal fossa** above (2) the **zygomatic arch** and its anterior frontal extension and posterior supra mastoid continuation (p. 22) which limit the temporal fossa below (3) the bones which form the floor of the temporal fossa (4) the **infra-temporal crest** on the great wing of the sphenoid which separates the temporal fossa from the infra temporal fossa (5) the **foramen ovale**, the **foramen spinosum**, and the **spine of the sphenoid** on the infra temporal surface of the great wing of the sphenoid (6) the **medial** and **lateral pterygoid plates** and the **pterygoid fossa** between them (7) the parts of the **glenoid cavity** of the temporal bone, namely the tympanic plate, the glenoid fossa, and the eminentia articularis (8) the **tuberosity of the maxilla**, a rough eminence behind the last molar tooth and (9) the parts of the **mandible** and their general characters.

The large **muscles of mastication** are four in number. They arise from the bones of the skull and are inserted into the ramus of the mandible. Two of them, the **masseter** and the **temporal muscle**, are comparatively superficial, but the other two, the **external** and **internal pterygoid** muscles, are more deeply placed. Their position and general relations are shown in Fig 45. The **masseter muscle** is the first to be examined. Its surface is more or less completely exposed, but its fibres require to be cleaned of the thin covering fascia to demonstrate their direction. The bulk of them, as seen from the surface, run parallel with one another downwards and backwards from the zygomatic arch to the region of the angle of the jaw and form the superficial part of the muscle but behind them at the upper end of the muscle a small triangular area of a deeper more vertical part can be defined (Fig. 13).

The **masseter** is a powerful quadrate muscle which covers the coronoid process and ramus of the mandible; it leaves uncovered the neck and condyle of the bone. Its fibres are arranged in two sets. The superficial fibres arise from the lower margin of the anterior two-thirds of the zygomatic arch and, bipennately arranged on a tendinous septum, are directed downwards and backwards. The deep fibres, some of which are seen behind the superficial fibres, are attached to the posterior third of the lower margin and the whole length of the deep surface of the zygomatic arch, and run downwards and very slightly forwards. The two parts of the muscle are separated behind by fibrous tissue but are fused in front. They are inserted on the outer surface of the coronoid process and ramus of the mandible, reaching as far as the angle of the jaw, the superficial fibres of course being at the lower level. The origin of the deep fibres and the insertion of the muscle will be displayed when it is reflected.

The **temporal muscle**, now to be examined, arises from the side of the skull over the area of the temporal fossa, and its fibres, converging strongly, pass downwards deep to the zygomatic arch to be inserted on the coronoid process of the mandible (Fig. 45). Above the zygoma the muscle is covered by a strong glistening membrane, the **temporal fascia**, the extent and attachments of which are to be studied before it is removed.

The **temporal fascia** is a strong aponeurotic fascia which covers the temporal muscle over the area of the temporal fossa. The upper part of the fascia is thin and the fibres of the muscle can be seen through it; its lower part, however, is much thicker and, owing to the fat between its layers, perfectly opaque. It is attached above to the upper of the two lines which form the temporal ridge on the side of the skull and in front to the margin of the zygomatic process of the frontal bone. About an inch below it attachment it splits into two layers which are fixed below to the whole length of the zygomatic arch, the superficial layer to the upper margin of the arch and the deep layer to its medial surface (Fig. 45). Between the two layers there is a narrow space filled with fat, as can be demonstrated by dividing the superficial layer close to its attachment and turning it upwards. If the fat is then scraped away the deeper layer will be brought into view. The middle temporal artery pierces the fascia immediately above the zygomatic arch.

The temporal fascia must be removed to display the temporal muscle. It should be detached from the zygomatic arch and turned upwards, and while doing so the dissector must preserve, if possible, the **middle temporal artery**, a branch of the superficial temporal artery which pierces it; at the same time it should be noted that some fibres of the temporal muscle are attached to the deep surface of the fascia. The lower part of the temporal muscle is to be displayed by the removal of the zygomatic arch with the masseter muscle attached to it, and before this dissection is commenced the dissector is warned that while it is being carried out he must secure the **nerve and artery to the masseter**. The zygomatic arch is to be sawn through as far back as possible without injuring the temporo-mandibular joint, and in front an oblique saw-cut is to be made through the zygomatic bone; this incision should extend

in front of the masseter from the extreme anterior end of the upper margin of the arch downwards and forwards to the point where its lower margin meets the zygomatic process of the maxilla. In making the incisions it is best only to saw partially through the bone and to complete the division with the bone forceps. The zygomatic arch with the masseter attached to it, is now freed and is readily turned downwards and as this is being done the masseteric nerve and artery which enter the deep surface of the upper part of the muscle from behind the posterior border of the temporal muscle will be found. They are to be identified,

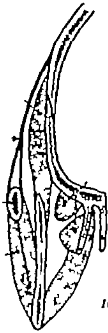


FIG. 43.
Diagram to show the position and relations of the muscles of mastication.

cleaned and then divided and the reflection of the muscle is to be continued to the angle of the mandible. The origin of the deep fibres of the masseter from the medial surface of the zygomatic arch and the insertion of the muscle on the coronoid process and ramus of the jaw will now be seen. The surface of the temporal muscle is to be cleaned. (Occasionally a few fibres of the masseter muscle arise from the deep surface of the temporal fascia bove the zygomatic arch they are continuous with, and appear to be part of the temporal muscle. They must be divided.)

The temporal muscle (Fig 43) arises from the whole area of the temporal fossa, except the anterior zygomatic wall, bet een the lower temporal line

and the infra temporal crest on the great wing of the sphenoid bone (On a skull the student should identify the various bones which lie in the temporal fossa and to which the muscle is attached.) In addition there are some fibres attached to the deep surface of the temporal fascia. The muscle fibres converge towards the coronoid process of the mandible the anterior fibres passing almost vertically downwards and the posterior fibres almost horizontally forwards. Near its insertion a tendon appears on the surface of the muscle and is joined by the superficial fibres; it is inserted on the summit and anterior edge of the coronoid process. The deep part of the muscle however remains fleshy and is inserted on the inner surface of the coronoid process and for a varying distance on the inner face of the ramus of the mandible; usually it reaches as far as the last molar tooth. This deep insertion cannot be seen at present but will be noted at a later stage of the dissection.

The temporal muscle is to be reflected upwards by separating the coronoid process from the mandible. An oblique incision is to be made with the saw from the lower margin of the mandibular notch downwards and forwards to the point where the ramus joins the body of the mandible The saw-cut should not be carried quite through the bone but the division completed by striking the part to be detached sharply with the mallet The coronoid process with the temporal muscle can now be turned upwards but there is some difficulty in defining the lower part of the muscle when its insertion is carried far downwards on the ramus some tendinous fibres will probably have to be divided. The **buccal nerve** and the accompanying **buccal artery** are then in danger of being cut they run downwards and forwards deep to the coronoid process under cover of the temporal muscle but not infrequently the nerve is embedded in its anterior fibres These structures having been secured however the temporal muscle is to be separated with the handle of the knife from the lower part of the temporal fossa and in doing so the **deep temporal arteries** and **nerves** which ascend between the cranial wall and the muscle and supply the muscle are to be secured and cleaned. The **middle temporal artery** having pierced the temporal fascia and penetrated the temporal muscle in front of the ear ascends in a groove on the squamous temporal bone it supplies the posterior part of the temporal muscle and anastomoses with the posterior deep temporal artery which lies in front of it

The **external** and **internal pterygoid muscles** are now partly exposed, but the region in which they lie, the infra temporal or pterygoid region is to be more fully opened up by removing the greater part of the ramus of the jaw This is to be done by sawing the bone transversely first through the neck of the mandible and then just above the level of the **inferior dental foramen**. The level of the foramen is to be found by passing the handle of a scalpel downwards on the deep surface of the ramus it will be stopped at the foramen by the entrance of the **inferior dental vessels** and **nerve** into it. In making these incisions the saw is not to be carried quite through the bone the division should be completed with the bone forceps. The separated bone is to be removed.

The contents of the infra temporal region are embedded in a fatty

in front of the masseter from the extreme anterior end of the upper margin of the arch downwards and forwards to the point where its lower margin meets the zygomatic process of the maxilla. In making the incisions it is best only to saw partially through the bone and to complete the division with the bone forceps. The zygomatic arch, with the masseter attached to it, is now freed and is readily turned downwards and as this is being done the masseteric nerve and artery which enter the deep surface of the upper part of the muscle from behind the posterior border of the temporal muscle will be found. They are to be identified,

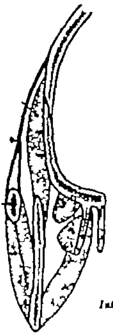


FIG 45.

Diagram to show the position and relations of the muscles of mastication.

cleaned, and then divided and the reflection f the muscle is to be continued to the angle of the mandible. The origin of the deep fibres of the masseter from the medial surface of the zygomatic arch and the insertion of the muscle on the coronoid process and ramus of the jaw will now be seen. The surface of the temporal muscle is to be cleaned. (Occasionally a few fibres of the masseter muscle arise from the deep surface of the temporal fascia above the zygomatic arch they are continuous with, and appear to be part of the temporal muscle. They must be divided.)

The temporal muscle (Fig. 45) arises from the whole area of the temporal fossa, except the anterior zygomatic wall, between the lower temporal line

and the infra temporal crest on the great wing of the sphenoid bone (On a skull the student should identify the various bones which lie in the temporal fossa and to which the muscle is attached.) In addition there are some fibres attached to the deep surface of the temporal fascia. The muscle fibres converge towards the coronoid process of the mandible the anterior fibres passing almost vertically downwards and the posterior fibres almost horizontally forwards. Near its insertion a tendon appears on the surface of the muscle and is joined by the superficial fibres; it is inserted on the summit and anterior edge of the coronoid process. The deep part of the muscle however remains fleshy and is inserted on the inner surface of the coronoid process and for a varying distance on the inner face of the ramus of the mandible; usually it reaches as far as the last molar tooth. This deep insertion cannot be seen at present but will be noted at a later stage of the dissection.

The temporal muscle is to be reflected upwards by separating the coronoid process from the mandible. An oblique incision is to be made with the saw from the lower margin of the mandibular notch downwards and forwards to the point where the ramus joins the body of the mandible. The saw-cut should not be carried quite through the bone but the division completed by striking the part to be detached sharply with the mallet. The coronoid process with the temporal muscle can now be turned upwards but there is some difficulty in defining the lower part of the muscle when its insertion is carried far downwards on the ramus some tendinous fibres will probably have to be divided. The **buccal nerve** and the accompanying **buccal artery** are then in danger of being cut they run downwards and forwards deep to the coronoid process under cover of the temporal muscle, but not infrequently the nerve is embedded in its anterior fibres. These structures having been secured however the temporal muscle is to be separated with the handle of the knife from the lower part of the temporal fossa and in doing so the **deep temporal arteries and nerves** which ascend between the cranial wall and the muscle and supply the muscle are to be secured and cleaned. The **middle temporal artery** having pierced the temporal fascia and penetrated the temporal muscle in front of the ear ascends in a groove on the squamous temporal bone it supplies the posterior part of the temporal muscle and anastomoses with the posterior deep temporal artery which lies in front of it.

The **external and internal pterygoid muscles** are now partly exposed but the region in which they lie, the infra temporal or pterygoid region is to be more fully opened up by removing the greater part of the ramus of the jaw This is to be done by sawing the bone transversely first through the neck of the mandible and then just above the level of the **inferior dental foramen**. The level of the foramen is to be found by passing the handle of a scalpel downwards on the deep surface of the ramus it will be stopped at the foramen by the entrance of the **inferior dental vessels** and **nerve** into it. In making these incisions the saw is not to be carried quite through the bone the division should be completed with the bone forceps. The separated bone is to be removed.

The contents of the infra temporal region are embedded in a fatty

areolar tissue which must be removed with some care to avoid injury to them. A diagram of the dissection to be accomplished is shown in Fig 46. The veins of the region are to be sacrificed. The external pterygoid muscle, whose fibres run almost transversely backwards to be attached to the neck of the mandible, should be defined first it has two heads, an upper head and a lower head. At its lower border lies the internal pterygoid muscle whose fibres run downwards and back wards to the deep surface of the mandible. A few fibres of the internal

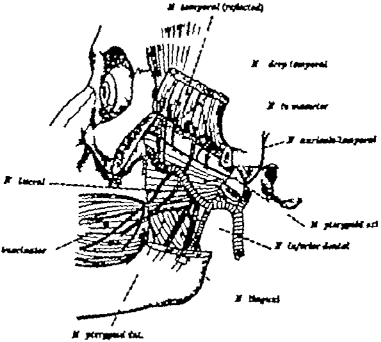


FIG. 46.

Diagram of dissection of the infra-temporal region. The maxillary artery and its branches are to be coloured and named.

pterygoid forming the superficial of its two heads, will be seen to lie on the surface of the lower head of the external pterygoid but most of them, forming the deep head pass deep to it. The maxillary artery a terminal branch of the external carotid artery and arising from it in the substance of the parotid gland is then to be cleaned. It passes forwards along the lower border of the external pterygoid and then usually on the surface of its lower head and finally leaves the space by passing between the two heads of the muscle to enter the deeply placed pterygo-palatine fossa frequently however it passes deep to the lower head of the muscle, and then only its commencement and end

part can be defined It gives off numerous branches from its upper and lower borders and these are to be secured and cleaned

The **veins of the infra-temporal space** form a network the **pterygoid plexus**, round the external pterygoid muscle. The plexus communicates with the veins of the orbit and the cavernous sinus within the skull and is drained in front by the deep facial vein (p 45) and behind by the maxillary vein which passes backwards below the artery and enters the parotid gland.

The **nerves of the space** are branches of the **mandibular division of the trigeminal nerve** which itself lies deep to the external pterygoid the branches escape therefore from under cover of the muscle At its upper margin there appear the **masseteric nerve**, which reaches the masseter muscle through the mandibular notch, and the two **deep temporal nerves** which ascend on the bone deep to the temporal muscle and supply it The **lingual and inferior dental nerves** emerge from below the lower border and descend on the surface of the internal pterygoid muscle the latter nerve resting on and being separated from the muscle by the **spheno-mandibular ligament** as it enters the mandibular foramen it gives off on its way the **mylo-hyoid nerve** which pierces the ligament. The **buccal nerve** emerges between the two heads of the external pterygoid and passes downwards and forwards over the lower head to the surface of the buccinator muscle while appearing from behind the neck of the mandible, and ascending in front of the ear there is the **auriculo-temporal nerve.**

These structures are now to be studied in detail commencing with the pterygoid muscles.

The **external pterygoid muscle** (Fig 46) arises by two heads. The upper head springs from the infra temporal crest and the infra temporal surface of the great wing of the sphenoid bone and the lower arises from the lateral surface of the lateral pterygoid plate The fibres of the two heads, pale in colour converge as they pass backwards and form a narrow musculo-tendinous bundle which is inserted on the depression on the anterior surface of the neck of the mandible and, bore it into the capsule of the *temporo-mandibular* joint through the capsule the muscle is fixed to, and acts on, the articular disc of the joint (Fig 47)

The **internal pterygoid muscle** (Fig 46) also arises by two heads; they embrace the origin of the lower head of the external muscle. The superficial head, small in size, arises from the *posterior part of the tuberosity of the maxilla* and the rough lateral surface of the tuberosity of the palat bone and the deep head, which arises deep to the xternal pterygoid is attached to the medial surface of the lateral pterygoid plate and to that part of the tuberosity of the palate which ppears between the two pterygoid plates. The fibres of the two heads proceed downwards and backwards applied to the deep surface of the ramus of the mandible, much as the masseter is pplied to its superficial surface, and are inserted int its back part between the mandibular foramen and the angle of the jaw; between the muscle and the bone there lie the spheno-mandibular ligament, the inferior dental artery and the inferior dental and lingual nerves.

The maxillary artery is the larger of the two terminal branches of the external carotid artery. It arises in the parotid gland immediately behind the neck of the mandible and, having left the gland on its antero-medial surface, runs forwards, deep to the jaw, to the anterior part of the infra-temporal region; there it disappears from view between the two heads of the external pterygoid muscle and enters the pterygo-palatine fossa. For descriptive purposes it is divided into three parts, the details of which are as follows (Fig. 46):—

The first part of the artery runs forwards below the lower border of the external pterygoid tendon between the neck of the mandible and the spheno-mandibular ligament, crossing the inferior dental nerve much more commonly on its superficial side. The second part crosses the lower border and lies on the surface of the lower head of the external pterygoid, on which it extends obliquely upwards and forwards. In this position it is under cover of the insertion of the temporal muscle. While this is the more common arrangement, almost as frequently in Europeans (45 per cent. of subjects) the second part of the artery passes deep to the external pterygoid muscle. Even when this occurs, however, the artery usually makes a bend forwards in the interval between the two heads of the muscle and appears on its surface before entering the pterygo-palatine fossa. The third part dips between the two heads of the external pterygoid muscle to reach the pterygo-palatine fossa, in which it is distributed.

The branches of the maxillary artery are very numerous and arise from its three parts (Fig. 46).

The branches of the second part are distributed to the neighbouring muscles. They are: (1) the two deep temporal arteries, anterior and posterior, pass up into the temporal fossa deep to the temporal muscle and supply it and the cranial bones; (2) a masseteric branch runs horizontally outwards behind the temporal muscle, and was seen to enter the deep surface of the masseter; (3) the pterygoid branches are a number of twigs, uncertain in their origin and course, to the pterygoid muscles; and (4) the buccal artery accompanies the buccal nerve and supplies the buccinator muscle and the mucous membrane of the cheek.

The branches of the first part are: (1) the deep auricular, tympanic, and middle meningeal arteries, which run upwards under cover of the external pterygoid muscle and, therefore, cannot be studied until that muscle is reflected; and (2) the inferior dental artery, which runs downwards. It descends on the surface of the spheno-mandibular ligament to the mandibular foramen, into which it passes; before it enters the bone it gives off a small mylo-hyoid branch. It lies posterior to the inferior dental nerve and is generally accompanied by two venæ comites, which end in the pterygoid plexus. It traverses the lower jaw in the mandibular canal and supplies the teeth, and appears as the mental artery at the mental foramen with the mental branch of the inferior dental nerve. The mylo-hyoid branch runs with the mylo-hyoid nerve in its groove on the deep surface of the mandible to the superficial surface of the mylo-hyoid muscle, where it was secured in the dissection of the submandibular triangle.

The only branch of the third part which can be seen at present is the posterior superior dental artery. It descends on the posterior surface of the

maxilla and gives off branches which enter the superior dental canals to supply the molar and bicuspid teeth other branches of it are distributed to the lining membrane of the maxillary antrum and the gums.

The maxillary vein (or veins) is a short wide trunk which issues from the posterior part of the pterygoid plexus. It accompanies the first part of the maxillary artery into the parotid gland and in it joins the superficial temporal vein to form the posterior facial vein (Fig 8).

The **tamporo-mandibular** joint is to be examined at this stage of the dissection so that afterwards the external pterygoid muscle may be reflected and the parts beneath it exposed. The joint is surrounded by a loose thin fibrous **capsule** which is attached below to the neck of the mandible and above to the margins of the articular fossa reaching in front to the anterior margin of the articular eminence and behind to the anterior edge of the petro-tympanic fissure the fissure itself which serves for the passage of vessels and nerves to and from the middle ear is outside the capsule The back of the capsule is in contact with the glenoid process of the parotid gland Some fibres of the external pterygoid muscle are attached to it in front (Fig 47) Its lateral surface is thickest and there is there a short thick band of fibres, broader above than below which is attached above to the tubercle at the root of the zygoma and runs downwards and backwards to the neck of the mandible it is named the **temporo-mandibular ligament** and it is to be noted that its obliquity allows the jaw to move downwards and forwards but that it is stretched in all backward movements. On the medial side of the joint and in great part already exposed there is a long membranous band, the **spheno-mandibular ligament** it is not part of the capsule but is conveniently described as an accessory ligament of the joint Its upper part lies deep to the external pterygoid muscle.

The spheno-mandibular ligament is a thin band narrow abo where it is attached to the spine of the sphenoid bone but broader below where it is fixed to the lingula at the mandibular foramen. It is not part of th capsule nor is it in direct relationship with it, for intervening between it and the mandible there are from above downwards, a mass of areolo-fatty tissue in which lies the auriculo-temporal nerve the tendon of the external pterygoid muscle, the maxillary essels, and the inferior dental vessels and nerve It is pierced near its lower ttachment by the mylo-hyoid vessels and nerve

The stylo-mandibular ligament is also sometimes included as an accessory ligament of the joint. It is, however merely a thickened part of the deep cervical fascia which invests th parotid gland. It is ttached bove to the styloid process and below to the angle of the mandible between the masseter and internal pterygoid muscles.

The capsule is to be removed from the lateral surface of the joint and its cavity freely opened Within the cavity there will be seen the **articular disc**, an oval plate of fibro-cartilage which is interposed between the head of the mandible below and the glenoid fossa and the eminentia articularis above The disc is attached at its periphery to the inner

surface of the capsule and thus divides the joint cavity into upper and lower parts, the upper of which is the larger each cavity is provided with its own synovial membrane (Fig. 47)

The articular disc, oval in shape with its long axis placed transversely is closely adapted to the two articular surfaces between which it lies. Its under surface is thus concave and is moulded over the top and anterior surface of the condyle of the mandible, while its upper surface is concave in front over the eminentia articularis and convex behind where it is adapted to the glenoid fossa. Its back part is much the thickest and fits into the deepest part of the glenoid fossa; its centre part is thinnest, and sometimes, indeed, it is perforated there. It is formed chiefly of dense fibrous tissue.

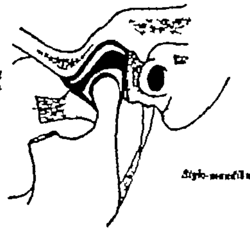


FIG. 47

Diagram of the structure of the temporo-mandibular joint. The joint has been opened to show the articular disc separating the two synovial cavities; the size of the disc and the cavities is exaggerated.

The condyle of the jaw is to be disarticulated from the glenoid fossa but before this is done the student is to study the form of the articulating surfaces, their relations to one another and the movements that take place at the joint he i to aid his study by an examination of the articulated skull.

The articular surfaces of the joint ar the condyle of the mandible, the glenoid surface on the squamous part of the temporal bone which includes the glenoid fossa and the articular eminence and the articular disc (Fig 47). The condyle of the mandible has the form of a part of cylinder the long axis of which is directed medially and backwards. It is carried on the neck of the bone which is bent little forwards. The articular surface of the condyle is limited to its front part; when the ja is closed it lies behind and is opposed to the sloping posterior surface of the articular eminence. It is covered with a layer of fibro-cartilage; the back part of the condyle, though intracapsular

is covered with a layer of fibrous tissue The glenoid surface is much larger than the condyle and allows it horizontal rotation on it It is covered in its whole extent with fibro-cartilage which is continued onto the fore part of the articular eminence the tympanic plate behind the petro-tympanic fissure is covered with fibrous tissue and supports a process of the parotid gland. The glenoid fossa is oval with it long axis directed medially and backwards; it receives not so much the *condyle of the mandible* as the thick posterior part of the articular disc.

The movements of the mandible itself, as occur in chewing and talking, are (1) depression and elevation, (2) protrusion and retraction, and (3) side to side or grinding movements. They take place at the jaw joints, the two joints working together but there each movement requires a pecial combination of displacements of the condyle on the articular disc and the articular disc on the glenoid surface. In the dead subject, it is true, a simple rotatory hinge movement of the condyle can be produced but in the living the rotation of the condyle is always combined with a downward and forward movement of it and the articular disc which follows the condyle in all its displacements. There are, therefore, two kinds of movement within the joint In the upper compartment the movement is one of gliding of the articular disc, whereby it, and the condyle with it can be carried downwards and forwards on the articular eminence. This i the movement that occurs at the joint when the mandible is protruded, and it is ffected by the external pterygoid muscle, which is attached both t the bone and the disc, aided to a small extent by the internal pterygoid and the superficial part of the masseter When the jaw is retracted the disc and the condyle glid backwards and upwards, the active muscles being the posterior horizontal part of the temporal and the deep part of the masseter the backward movement is limited by the temporo-mandibular ligament which prevents the condyle being carried onto the thin tympanic plate

In the lower compartment of the joint the condyle of the mandible can rotate on the lower surface of the disc, and in depressing the mandible to open the mouth this rotary movement is combined with the forward gliding movement in the upper compartment; this combined displacement, and the depression it produces behind the condyle, the student can readily feel on himself by palpation. The jaw is depressed by it own weight and by the contraction of the external pterygoid (upper compartment movement) and the mylo-hyoid, genio-hyoid, and digastric muscles (lower compartment movement); the platysma does not seem to be used. The contraction f the supra-hyoid muscles requires the fixation of the hyoid bone and for this purpose the infra hyoid muscles contract; the quivering of the posterior belly of the omo-hyoid can be seen in a thin person while talking When the mouth is widely open the condyle is just behind the summit of the articular eminence, the disc itself having moved onto it; in this position the condyle can readily be dislocated forwards by a spasmodic contraction of the external pterygoid, for the closing muscles have then lost a large part of their power since the line of action of the masseter and internal pterygoid passes through, or very near to, the turning axis of the jaw In elevation of the mandible a in closing the mouth the reverse gliding and rotatory movements take place in the joint. The active muscles are the masseter temporal, and internal pterygoid. They act in concert and do so with their maximum power when the molar teeth are in contact.

In the side to sid grinding movements a rotation of one condyle round vertical axis (lower compartment movement) is combined with forward

and backward gliding movement (upper compartment movement) in the opposite joint, the disc of course taking part in this movement; the active muscles are the elevating muscles of the side towards which the point of the jaw is moving and the external pterygoid of the opposite side.

The movements of the articular disc in opening and closing the mouth are sometimes so free as to produce an audible snap.

The condyle of the jaw with the articular disc attached to it, must be disarticulated from the glenoid cavity; care is required not to cut the auriculo-temporal nerve which lies close to the medial surface and back of the joint. When the condyle is freed it is to be pushed under the maxillary artery if necessary; the external pterygoid muscle can then be turned forwards and the parts beneath it brought into view. The nerve to the muscle enters its deep surface; it is to be isolated

(A) (B)

FIG. 48.

Diagrams to show the position of the mandibular condyle and articular disc when the mouth is closed (A) and open (B).

and divided. The middle meningeal artery and the two smaller branches, the small meningeal and tympanic arteries which usually arise from it, are to be cleaned first; they are embedded in areolo-fatty tissue.

The middle meningeal artery arises from the first part of the maxillary artery and proceeds upwards deep to the external pterygoid muscle. It is usually embraced by the two roots of the auriculo-temporal nerve (Fig. 40). It enters the cranial cavity, within which it is distributed, through the foramen spinosum. It usually gives off the small meningeal artery, which runs forwards and upwards and enters the skull through the foramen ovale; this vessel may arise however directly from the maxillary artery. The tympanic artery runs upwards and backwards and enters the tympanic cavity, in which it is distributed, through the petro-tympanic (Glaserian) fissure.

A further small branch of the first part of the maxillary artery, the deep auricular artery, should also be sought though it is not often seen. It pierces the anterior wall of the external auditory meatus and is distributed to its lining and the tympanic membrane.

The **mandibular** (third) **division of the trigeminal** (fifth cranial) **nerve** is now to be dissected It enters the infra temporal fossa from the cranial cavity through the foramen ovale and in it lies deep to the external pterygoid muscle on the surface of the **tensor palati muscle** and in front of the middle meningeal artery It gives off two small branches the **nervus spinosus** and the **nerve to the internal pterygoid**, and almost immediately divides into two parts which are named the **anterior and posterior divisions** (Fig 49)

The **nervus spinosus** is a very slender twig which passes through the foramen spinosum with the middle meningeal artery and is distributed with it It terminates in the dura mater The **nerve to the internal pterygoid** runs downwards and passes under the upper end of the posterior border of the muscle nd supplies it. The otic ganglion lies close to its commencement.

The **anterior division** of the mandibular nerve is smaller than the posterior division. It is composed almost entirely of motor fibres which are distributed to the muscles of mastication the only sensory fibres it contains are those which form the **buccal nerve** (Fig 49)

The **branches to the temporal muscle** are usually two in number anterior and posterior; the posterior is the smaller They pass upwards into the temporal fossa from above the upper margin of the external pterygoid muscle (Fig 46). The **masseteric nerve** often arises in common with the posterior temporal branch. It appears above the upper margin of the external pterygoid muscle and runs horizontally laterally behind the insertion of the temporal muscle to reach the deep surface of the masseter The **buccal nerve** is the largest branch of the anterior division (Fig. 49) It ppears from between the two heads of the external pterygoid muscle and runs downwards nd forwards over the lower head to the surface of the buccinator muscle where it unites with branches of the facial nerve to form the buccal plexus. From the plexus it is distributed to the mucous membrane and the skin of the cheek. In its course forwards it often pierces th anterior fibres of the temporal muscle to which it may give off a small branch (Fig 40). The **nerve to the external pterygoid** arises, as a rule, with the buccal nerve. It passes into the interval between the two heads of the muscle and gives a branch to each head.

The **posterior division** of the mandibular nerve is almost entirely a sensory nerve. It is distributed in three large branches the **auriculo-temporal, inferior dental, and lingual nerves**, into which it divides close to the base of the skull. The few motor fibres it contains are continued into the inferior dental branch they leave it, however as it enters the mandibular foramen as the **mylo-hyoid nerve**. The auriculo-temporal nerve will require to be carefully dissected out of the tough fibrous tissue on the deep surface of the jaw joint it arises by two roots which embrace the middle meningeal artery The inferior dental and lingual nerves are easily defined and if the lingual nerve is pulled forwards there will be found passing deep to the inferior dental nerve and joining its upper part from behind the **chorda tympani nerve**, a branch of the facial nerve.

The auriculo-temporal nerve arises by two roots, though sometimes the deeper of them is absent. They embrace the middle meningeal artery and unite behind it to form the stem of the nerve. This runs backwards beneath the external pterygoid muscle and passes between the neck of the mandible and the spheno-mandibular ligament. It then turns upwards behind the jaw joint and in front of the auricle, being closely related to, or even in the substance of, the antero-medial surface of the parotid gland; here it gives

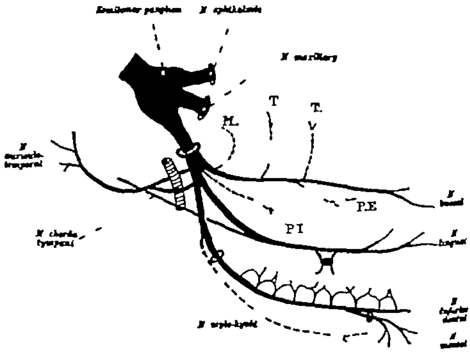


FIG. 40

A scheme of the mandibular nerve and its branches. The motor branches are in broken lines and the sensory branches in solid lines. The middle meningeal artery and the submandibular ganglion are shown.

T deep temporal nn.; M., masseteric n.; P.I., nerve to internal pterygoid; and P.E., nerve to external pterygoid muscle.

off twigs to the joint and branches which enter the gland both to supply it with secreto-motor fibres and to join the facial nerve. It emerges from the upper border of the parotid gland and crosses the zygomatic arch immediately behind the superficial temporal artery and in company with it is distributed to the temporal region of the scalp. In its course in front of the auricle it gives off branches to it which supply its upper and anterior part and others which supply the skin lining the anterior and upper walls of the external meatus. The secreto-motor fibres to the parotid gland reach the nerve through communicating twigs from the otic ganglion to its roots.

The inferior dental nerve, having emerged from under cover of the lower border of the external pterygoid muscle lies on the internal pterygoid behind the lingual nerve to which it is often connected It then descends between the ramus of the jaw and the spheno-mandibular ligament to the mandibular foramen. It enters the mandibular canal in company with the inferior dental artery which lies behind it but before it enters it gives off the slender mylohyoid nerve (Fig 49). This branch, accompanied by the artery of the same name pierces the spheno-mandibular ligament and runs downwards and forwards in a groove on the deep surface of the mandible It has already been dissected in the submandibular triangle of the neck, where it supplies the anterior belly of the digastric and the mylo-hyoid muscle

The lingual nerve is a sensory nerve Like the inferior dental nerve, which lies behind it, it runs downwards deep to the external pterygoid muscle and appears at its lower border It then passes downwards and forwards on the surface of the internal pterygoid muscle deep to the ramus of the jaw and, just behind and medial to the third molar tooth, enters the submandibular region; there it will afterwards be secured and traced to the front part of the tongu and the mucous membrane of the floor of the mouth. While still deep to the ext rnal pterygoid muscle it is joined by the chorda tympani; and it is usually connected to the inferior dental nerve by a transverse branch.

The chorda tympani is a branch of the facial nerve. It is a slender twig but is readily secured It emerges at the medial end of the petro-tympanic fissure and runs downwards and forwards, deep to the spheno-mandibular ligament and the inferior dental nerve, and joins the upper part of the lingual nerve at an acute angle (Fig 49). Its distribution will be studied later

The student should now open the mandibular canal by removing the outer table of the mandible over it with a small saw the chisel and the bone forceps the dissection is not difficult There will be exposed within the canal the **inferior dental vessels** and **nerve**. They give off branches to the teeth and the adjoining parts of the gums and **mental branches** which issue through the mental foramen they were secured in the dissection of the face (p. 49) and traced to their distribution on the chin.

The nerves to the teeth of the lower jaw arise from special branches of the inferior dental nerve for the molar bicuspid, and incisor teeth. Each branch breaks into a plexus formation for the supply of a tooth group and from the plexuses several fine filament enter the foramina t the apices of the roots. The incisor branch usually emerges through the mental foramen and forms its plexus on the surface of the mandible, the plexuses of the two sides often communicating with one another; the incisor teeth may thus have a bilateral innervation. The canine tooth is supplied either from the bicuspid or th incisor plexus. The incisor artery lies in a continuation of the mandibular canal.

The student is to not (1) that the mandibular foramen can be reached from the mouth if a needle is inserted on the medial side of the ramus of the mandible one-third of an inch bove the crown of the third molar tooth and pressed backwards and slightly laterally for half an inch; ( ) that the roots of the third molar tooth are close to, or actually within, the mandibular canal, so that the contained nerve may be damaged in the extraction of the tooth; and

(3) that at the mental foramen the mandibular canal turns upwards and backwards so that the foramen is best entered from the surface in downward and forward direction.

The Submandibular Region

The submandibular region, the region under the body of the mandible and above the hyoid bone, has already been superficially dissected as part of the submandibular triangle of the neck (p. 95) It is now necessary to carry the dissection deeper in order to expose the floor of the mouth and the side and root of the tongue from below The chief structures to be examined are the muscles of those parts, the mucous membrane that covers them above, and their vessels and nerves, and, in addition, the **submandibular** and **sublingual salivary glands**.

The sterno-mastoid muscle is to be thrown fully back to its insertion so that the **digastric** and **stylo-hyoid muscles** are exposed (Fig. 54). The attachments of these muscles are to be examined.

The **digastric muscle**, as its name implies, consists of two fleshy bellies which are united by an intervening tendon. The anterior belly arises from the deep surface of the lower border of the mandible close to the middle line, and the posterior belly arises from the digastric fossa on the medial side of the mastoid process of the temporal bone. The two bellies converge towards the hyoid bone and just above its upper border are united by the intervening tendon, which is attached to the hyoid bone by broad band of fibrous tissue; it acts as a pulley through which the tendon moves. Behind the band the tendon is embraced by the cleft lower end of the stylo-hyoid muscle. The anterior belly is subject to many variations; the most frequent of them is its subdivision int two parts, the medial of which may cross the middle line or blend with the mylo-hyoid muscle. The anterior belly is supplied by the mylo-hyoid branch of the mandibular division of the fifth nerve and the posterior belly by the stylo-hyoid branch of the seventh nerve.

The **stylo-hyoid** is a slender muscle which lies along the upper border of the posterior belly of the digastric It arises from the back of the middle part of the styloid process and is inserted into the hyoid bone, at the junction of the body and the great cornu, by two slips which embrace the tendon of the digastric muscle. It is supplied by a branch of the facial nerve.

The relations of the digastric and stylo-hyoid muscles have been considered in some measure already (p. 96) but it is convenient to revise them in the present dissection (Fig 36). The anterior belly of the digastric is superficially placed being covered only by the skin and the fascial tissues though it is often overlapped from behind by the submandibular gland Its deep surface is in contact with the mylo-hyoid muscle. The posterior belly is covered behind by the insertion of the sterno-mastoid and the mastoid process, and in front of them by the angle of the jaw and the insert n f the internal pterygoid muscle between these two parts it overlaid by the lower apical part of the parotid gland. In front f the angle of the jaw it is more superficially placed, being covered by the deep and superficial fasciæ, the platysma muscle and the skin and the nterior facial vein crosses it and it is

usually overlapped by the posterior part of the submandibular gland. Deep to it and to the stylo-hyoid muscle there are to be identified (1) the internal jugular vein and the internal and external carotid arteries (2) the facial artery which runs forwards under it and the occipital and posterior auricular arteries which pass backwards under cover of its lower and upper borders (3) the hypoglossal nerve which descends vertically on its deep surface in the interval between the internal jugular vein and the internal carotid artery (4) the accessory nerve which passes backwards between it and the internal jugular vein (5) the glosso-pharyngeal nerve which passes forwards and downwards between it and the internal carotid artery and (6) the posterior part of the hyo-glossus muscle.

The facial artery and the anterior facial vein are to be divided as they cross the mandible and the anterior belly of the digastric muscle is to be detached from the lower border. The mandible is then to be sawn through on each side of the middle line the two incisions being about half an inch apart special care must be taken not to divide the mylo-hyoid muscles or the mucous membrane of the floor of the mouth. The lateral parts of the mandible can now be everted and they are to be fixed in this position with hooks. The whole surface of the **mylo-hyoid muscle** is to be exposed by turning the **superficial part of the submandibular gland** backwards and on it there are to be found again the **mylo-hyoid nerve** and **artery** as well as the **submental artery** a branch of the facial artery. As the submandibular gland is turned backwards, it is to be noted that a process of it passes anteriorly under the posterior border of the mylo-hyoid muscle this is the **deep part of the gland** and from it the **submandibular duct** is continued forwards on the floor of the mouth. The attachments of the mylo-hyoid muscle are to be examined.

The **mylo-hyoid** is thin sheet of muscle which arises from the mylo-hyoid ridge on the deep surface of the mandible, extending from the last molar tooth behind almost to the middle line in front. Its fibres run towards the middle line and little downwards and backwards, parallel to one another. The posterior fibres are inserted int the body of the hyoid bone, but the larger number becoming shorter farther forwards, end in median tendinous raphe which extends from the symphysis of the jaw to the hyoid bone. The posterior border alone is free. The two muscles together form the floor (diaphragma oris) of the anterior part of the mouth (Fig. 52), and on their upper surface lie all the proper organs of the mouth; the vessels and nerves of these organs reach them by passing on each side under the posterior border of the muscle. The mylo-hyoid branch of the inferior dental nerve has already been traced t the surface of the muscle.

The **submandibular gland**, about half the size of the parotid gland lies in the floor of the mouth largely under cover of the lower jaw in front of its angle. It consists of two parts a larger superficial part, superficial to the mylo-hyoid muscle and a smaller deep part deep to it the two parts are continuous with one another round the posterior

of the muscle. The superficial part is to be examined. It fills the interval between the two bellies of the digastric muscle, overlapping both of them, and is enclosed in a sheath of deep cervical fascia which is loosely attached to it (p. 103).

The superficial part of the submandibular gland is much the larger part. Its deep surface rests on the mylo-hyoid muscle in front and on the hyo-glossus muscle behind, and usually it extends beyond the hyo-glossus and is in contact with the wall of the pharynx. The lingual and hypoglossal nerves are under cover of its back part, but they pass forwards under the mylo-hyoid muscle and are then related to the deep part of the gland (Fig. 60). The superficial part extends upwards under cover of the lower jaw as high as the mylo-hyoid ridge, its lateral surface being in contact with the jaw and filling the fossa there for it; behind the mylo-hyoid muscle the internal pterygoid lies lateral to it, and its upper edge is in contact with the mucous membrane of the floor

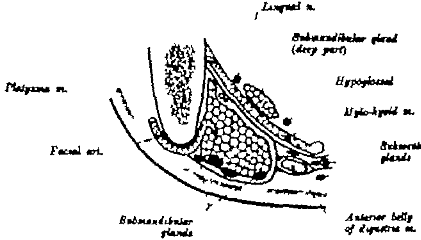


FIG. 60

Diagram of the relations of the submandibular gland as seen on vertical section

of the mouth and [illegible] be felt there in bimanual palpation, in front of the angle of the jaw. The [illegible] hyoid artery and nerve lying in the groove for them on the jaw [illegible] contact with the upper edge and then pass forwards under the deep surface [illegible] on the mylo-hyoid muscle. The lower or superficial surface [illegible] covered by the skin, the superficial fascia with the platysma, and the deep fascia, and is crossed by the [illegible] branches of the facial nerve (under the platysma) [illegible] the anterior facial [illegible] (under the deep fascia). The posterior end of the gland [illegible] the stylo-mandibular ligament which separates it from the parotid gland [illegible] left by [illegible] which holds the facial artery [illegible] and reappearing between the gland and the [illegible] edge. The front end of the [illegible] lies about the level of the mental foramen.

The gland has [illegible] which [illegible] of the gland substance [illegible] from the [illegible] fascia (p. 103), the superficial [illegible] be [illegible] finger.

The **submandibular lymph glands** form a chain in the groove between the lower border of the mandible and the submandibular gland. They vary in number but three large glands are fairly constant, the largest gland lying in the middle of the chain below the facial artery as it turns round the lower border of the mandible These glands lie deep to the deep fascia which covers the salivary gland, but outside its proper capsule. In children, however small lymph nodules are sometimes found within the capsule and even in the back part of the gland substance but they seem to degenerate in the adult. The submandibular glands drain the regions supplied by the facial artery namely the lateral parts of the chin, the lips, the cheeks, the external nose and the medial parts of the eyelids, and, in addition, the gums and teeth of both jaws, the hard and soft palate the front part of the tongue and the floor of the mouth. They drain in turn into the upper deep cervical glands.

The **submental lymph glands**, one to eight in number lie under the chin; most of them are under the deep fascia but often some of them are in the superficial fascia under the platysma They are palpable even when healthy They drain the chin, the middle part of the lower lip and the front part of the floor of the mouth including the front part of the tongue Their efferent vessels pass to the submandibular glands or directly to the deep cervical glands.

The mylo-hyoid muscle is to be cut through close to its origin from the lower jaw and turned forwards care being taken not to injure the mucous membrane of the mouth as it passes from the jaw to the side of the tongue and is in contact with it above. The **side of the tongue**, below the level of the mucous membrane is now brought into view

The **tongue** is essentially a muscular organ active in the movements of chewing sucking swallowing, and speaking. It practically fills the cavity of the mouth when it is shut its upper surface or dorsum, then being in contact with the palate. This surface is covered with a mucous membrane which is continued downwards on its sides and on the under surface of its anterior free part and is reflected from them onto the floor of the mouth. The **root of the tongue**, its fixed part lies below the mucous membrane on the floor of the mouth it is attached posteriorly to the styloid process and the hyoid bone and in front to the floor of the mouth and the symphysis of the mandible The fixation is effected mainly by its muscles. The **muscles of the tongue** comprise two groups namely (1) those which lie entirely within itself and form its principal mass, the **intrinsic muscles** and (2) those which arise from parts without the tongue and are inserted into it from below the **extrinsic muscles**. It is the extrinsic muscles alone which are to be examined in the present dissection they are symmetrical pairs and effect its gross movements. There also fall to be studied the **nerves** and the **vessels** of the tongue which, like the extrinsic muscles, enter its root from below

The **extrinsic muscles of the tongue** are well exposed and are readily identified (Fig. 51) The **hyo-glossus** is a flat quadrangular muscle which extends from the hyoid bone to the side of the tongue. Its anterior and posterior borders are to be defined the latter border being reached by displacing backwards the stylo-hyoid and the posterior belly of the digastric muscle passing deep to it is the **lingual artery**

In front of the hyo-glossus lie the **genio-hyoid** and **genio-glossus muscles**, the former muscle superficial to the latter and mingling with the fibres of the *upper part of its posterior border is the* ***stylo-glossus muscle.*** On the surface of the hyo-glossus there are to be recognised (Fig 51), (1) the **hypoglossal nerve** which lies close to the hyoid bone and is accompanied by the **lingual veins** (2) the **lingual nerve** which lies on the upper part of the muscle near its insertion into the tongue and (3) between the *hypoglossal and lingual nerves the* ***deep part of*** *the* **submandibular gland** and the **duct of the gland** which arises from it. Anterior to the hyo-glossus muscle and resting on the genio-glossus muscle, there will be seen the **sublingual gland** the lingual nerve and

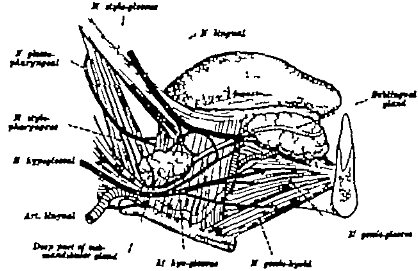


FIG. 51

Dissection of the submandibular region from the side. The mylo-hyoid muscle has been removed. The submandibular ganglion is suspended from the lingual nerve The submandibular duct and the lingual artery are to be coloured.

the duct of the submandibular gland pass f rwards deep to it. The attachments of the extrinsic muscles are now to be examined.

The *hyo-glossus (Fig 51) is a flat quadrate muscle which arises from* the whole length of the great cornu and the lateral part of the body of the hyoid bone. *Its fibres pass upwards t the posterior half of the side of the tongue,* and from there they spread forwards and in ard into its substance. There is often an accession *of fibres t the deep surface of the muscle from the lesser* cornu of the hyoid bone; they form the bondro-glossus muscle. The lingual artery *intervenes between it and the hyo-glossus.*

The stylo-glossus (Fig 51) is a slender fleshy slip which arises from the front of the styloid process, near ts t p, and from the stylo-mandibular

ligament to which, indeed, the greater number of its fibres are sometimes attached It passes forwards and downwards and is inserted on the side of the tongue from its base to its tip, its fibres decussating and blending with those of the hyo-glossus.

The **genio-hyoid** (Fig 51) does not belong to the tongue; it is a supra hyoid muscle, an elevator of the hyoid bone, and as such is used with the tongue in chewing, swallowing and speaking It is a short narrow muscle which lies close to the middle line and in cont ct with it fellow of the opposite side Its origin is from the lower genial tubercle on the deep surface of the symphysis of the jaw and it is inserted on the anterior surface of the body of th hyoid bone. It is supplied by a branch given off from the hypoglossal nerve but which consists of fibres derived from the first or first and second, cervical nerves (Fig 30)

The **hypoglossal nerve** was traced in the dissection of the anterior triangle of the neck as far as the posterior border of the mylo-hyoid muscle (p. 97) It is now seen passing forwards on the hyo-glossus muscle close to the hyoid bone (Fig 51) At the anteri border of the hyo-glossus it gains the surface of the genio-glossus muscle into the substance of whi h it sinks; there it breaks int branches which supply it and the intrinsic muscles of the tongue. In addition to supplying these muscles, it gives off branches to the stylo-glossus, hyo-glossus, and palato-glossus muscles, and communicates with the lingual nerve by one or more loops. The hypoglossal nerve may now be defined as th motor nerve to the intrinsic and xtrinsic muscles of the tongue and, through the communications it forms with the upper cervical nerves (Fig 30), it carries fibres which lea e it to supply the genio-hyoid and the infra-hyoid muscles. It is accompanied in its course on the side of the tongue by the main lingual vein which lies below it.

The **deep part of the submandibular gland** (Fig 51) is much smaller than the superficial part; it is continuous with it at the posterior border of the mylo-hyoid muscle. It extends forwards on the hyo-glossus muscle lying below the mucous membrane of the mouth its anterior extremity usually reaches the hinder end of the sublingual gland. The **duct of the gland** (Wharton duct) commences in the superficial part winds round the posterior border of the mylo-hyoid, and runs forwards deep to the deep part between th hyo-glossus nd mylo-hyoid muscles. It lies abo the hypoglossal nerve and at first below the lingual nerve but afterwards passes beneath it and lies at a higher level. It then rests on the genio-glossus muscle deep to the sub-lingual gland and, rising t its terminal part opens on the floor of the mouth beneath the tongu on the summit of a small papilla close to the middle line and at the anterior end of a ridge of mucous membrane known as the sublingual fold; the student is t examine the papilla and the fold in his own mouth. The duct is 4 to 5 cm. long and 3 mm in diameter it wall is thin and inelastic. A probe is to be passed into it by incising its orifice and it position under the mucous membrane of the floor of the mouth will then be appreciated

The **sublingual gland** (Fig 51) is the smallest of the three salivary glands. It lies at the side of the root of the tongue beneath the m cous membrane of the floor of the mouth and can be recognised there by the fold it produces, the sublingual fold. Its deep surface rests on the genio-glossus muscle and on the submandibular duct and the lingual nerve while its superficial surface is lodged in the sublingual depression on the deep surface of the mandible

bove the mylo-hyoid ridge. The mylo-hyoid muscle supports it below (Fig. 53). The gland is almond-shaped and about an inch long. It lies in loose areolar tissue and has no proper capsule. Its anterior end reaches the middle line and is in contact with the gland of the opposite side The ducts of the gland (ducts of Rivini) are from eight to twenty in number; they open into the mouth along the sublingual fold though some of them may join the submandibular duct. The gland is readily separated int lobes, each lobe having its own duct; it may well be considered an aggregation of separate glands.

The whole course of the lingual nerve from the foramen ovale to the submandibular region is to be shown by detaching the insertion of the internal pterygoid muscle from the inner surface of the mandible.

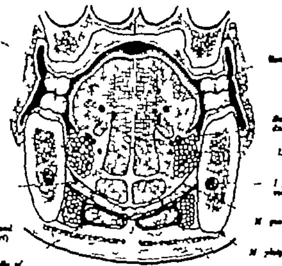


Fig 52.
Vertical section of the closed mouth behind the first molar teeth.

The nerve is to be traced forwards, noting especially its relation to the last molar tooth and the mucous membrane of the floor of the mouth and as it lies on the hyo-glossus muscle it is to be carefully cleaned and the submandibular ganglion which is suspended from it is to be isolated and defined.

The lingual nerve (Fig 31) has been followed from its origin from the mandibular nerve through the infra temporal region to the surface of the internal pterygoid muscle; t lies bet een it and the ramus of the jaw (Fig. 46). It then runs forwards between the jaw and the mucous membrane of the mouth below and behind the last molar tooth; here it may be injur d by the clumsy extraction of the tooth. It then runs forwards on the side of the tongue and, after crossing the stylo-glossus, lies on the surface of the hyo-glossus muscle. It communicates there

by one or more loops with the hypoglossal nerve and, having crossed the submandibular duct passes beneath the sublingual gland and breaks into its terminal branches. These pierce the substance of the tongue and supply the mucous membrane over its anterior two-thirds; other branches supply the mucous membrane of the floor of the mouth and the lower gum.

The lingual nerve is joined in the infra t mporal region by the chorda tympani nerve, a branch of the facial nerve This branch carries both sensory and motor fibres. The sensory fibres are distributed with the terminal branches of the lingual nerve to the mucous membrane of the anterior two-thirds of the tongue and are probably concerned in the transmission of impulses of taste the fibres of the lingual nerve proper subserve the transmission of common sensation and their main ending is in the filiform and fungiform papillae of the tongue. The motor fibres of the chorda tympani pass to the submandibular ganglion.

The **submandibular ganglion** (Fig 51) is of small size not larger than the head of a pin, and is suspended from the lingual nerve by two short branches. The posterior branch, often in the form of two or three filaments, conveys into the ganglion pre-ganglionic parasympathetic fibres from the chorda tympani nerve; the anterior branch, on the other hand, consists of post-ganglionic fibres which take origin in the ganglion and pass from it to the lingual nerve and are distributed t the sublingual gland Sympathetic fibres from the plexus round the facial artery also enter the ganglion. The ganglion gives off branches to the submandibular gland as well as those which pass by the lingual nerve t the sublingual gland. It must be looked on, therefore, as the place of origin of the secreto-motor fibres to the salivary glands of the floor of the mouth, and to be connected to th central nervous system by the horda tympani branch of the facial nerve; the sympathetic fibres pass through it without interruption.

The hyo-glossus muscle is to be separated from the hyoid bone and reflected upwards towards the tongue so that the structures which lie deep to it may be examined. These structures are (1) the **lingual artery** and its branches and the accompanying **veins**, which are to be cleaned (2) the posterior part of the **genio-glossus** muscle the insertion of which is to be exposed by removing the necessary amount of the mucous membrane of the tongue and (3) the attachment of the **stylo-hyoid ligament** to the lesser cornu of the hyoid bone

The **genio-glossus** is a flat fan-shaped muscle placed vertically and in contact with its fellow in the median plane (Fig 52). It arises by a short tendon from the upper genial tubercle on the deep surface of the symphysis of the mandible and from there its fibres spread out widely Th lowest fibres are inserted into the hyoid bone and a few int the side of the pharynx, but the great bulk of them pass into the substance of the tongue in which they extend from the tip to the base.

The **lingual artery** has been seen to arise from the external carotid artery and to pass medially in the carotid triangle to the posterior border of the hyo-glossus muscle in this part of its course it is crossed by the hypoglossal nerve and the posterior belly of the digastric and the stylo-hyoid muscle and gives off its supra hyoid branch (p 99) It then proceeds forwards under cover of the hyo-glossus, lying close

above the great cornu of the hyoid bone and resting on the middle constrictor muscle of the pharynx and then on the genio-glossus. In this part of its course it gives off its **dorsales linguæ** branches. At the anterior border of the hyo-glossus it turns vertically upwards and near the upper part of the border divides into its two terminal branches, the **ranine and sublingual arteries** (Fig 51)

The **dorsales linguæ** are generally two definite branches which ascend on the genio-glossus under the hyo-glossus muscle to the back part of the tongue, and supply its muscular tissue and the mucous membrane. A few twigs are given off by the posterior vessel to the tonsil and to the pillars of the fauces. The **sublingual artery** generally of good size, runs forwards and upwards with the submandibular duct between the genio-glossus muscle and the sublingual gland, both of which it supplies. It gives branches also to the mucous membrane of the floor of the mouth and the lower gum and anastomoses with its fellow of the opposite side. The **ranine artery** or deep artery of the tongue, ascends on the genio-glossus and then runs forwards on the under surface of the tongue t its tip. It can be exposed by reflecting a fold of the mucous membrane (plica fimbriata) which covers it. The course of the vessel is tortuous but the curves disappear when the tongue is stretched. There is little anastomosis between the branches of the two lingual arteries across the middle line, except between the ranine arteries near the tip of the tongue; the tongue may be split therefore in the median plane without much bleeding taking place.

Two small **venæ comitæ** which receive the dorsales linguæ veins accompany the lingual artery The main lingual vein, the **ranine vein**, however accompanies the hypoglossal nerve on the surface of the hyo-glossus muscle. It begins near the tip of the tongue and runs back on its under surface close to the middle line and it can be seen there in the living subject as tortuous or even plexiform essel through the mucous membrane. It descends along the anterior border of the hyo-glossus and, as a rule, passes ont its surface and lies below the hypoglossal nerve. The several veins unite at the posterior border of the hyo-glossus to form the lingual vein which opens into the common facial vein or directly into the i ternal jugular vein (p. 97).

The **stylo-hyoid ligament** is t be examined in this dissection. It is narrow fibrous cord of varying strength which is ttached t the tip of the styloid process and extends down ards and forwards to the lesser cornu of the hyoid bone under cover of the hyo-glossus. It often contains nodule of cartilage and sometimes is ossified ven in considerable part of its length the ossified part can be felt from within the pharyn immediat ly behind the tonsil.

The sensory nerve of the post rior part of the tongue the **glosso-pharyngeal** (ninth cranial) **nerve**, is to be secured as it emerges from between the internal jugular ein and the internal carotid artery behind the **stylo-pharyngeus muscle** (Fig 5) This muscle is the most posterior of the three tyloid muscles d t descends to the lowest level the stylo-hyoid should be retracted w ll backw rd to expose it. The glosso-pharyngeal nerve wind ve t lat ral surface and passes beneath the stylo-hyoid ligament to the upper part of the posterior border of the hyo-glossus m scle (Fig 1) nd since that muscle is reflected the nerve can be foll wed n it u so upw rd beneath the stylo-glossus

muscle to the back part of the tongue. It supplies the mucous membrane covering the side and dorsal surface of the posterior third of the tongue. It will be seen again in a later dissection.

A short return should be made at this stage of the dissection to the infra temporal region to display there the **otic ganglion**, a small ganglion similar in nature to the submandibular ganglion. The lingual and inferior dental nerves are to be divided a short distance below their origin so that the upper part of the mandibular nerve now freed can be turned upwards. The muscle fibres which are exposed and on which the middle meningeal artery rests, are those of the **tensor palati** (Fig 91) and lying on them, deep to the mandibular nerve and immediately below the foramen ovale and in front of the middle meningeal artery is the otic ganglion which should be secured.

The **otic ganglion** is a small pinkish body about 3 mm in length lying in the position described abov It surrounds the origin of the nerve to the internal pterygoid muscle and from it receives som fibres; and in addition there enter it (1) sympathetic fibres from the plexus round the middle meningeal artery and (2) the small superficial petrosal nerve which connects it to the facial and glosso-pharyngeal nerves and conveys to it pre-ganglionic parasympathetic fibres. It gives off (1) branches to the tensor palati muscle; (2) a branch to the tensor tympani muscle of the middle ear (3) a communicating branch to the chorda tympani; and (4) twigs to both roots of the auriculo-temporal nerve the fibres f which, arising in the ganglion, are carried to the parotid gland nd convey secreto-motor impulses from the glosso-pharyngeal nerve to the gland (p. 134). The branches to the muscles are deri ed from the nerve to the internal pterygoid; they pass through the ganglion without interruption. The connexions to the facial nerv probably consist of sensory fibres

DEEP DISSECTION OF THE UPPER PART OF THE NECK

The student must now return to the dissection of the neck and examine there the upper parts of the great vessels namely the **internal** and **external carotid arteries** and the **internal jugular vein**, and the course and distribution of the last four **cranial nerves**. He should first read again the general account of them on pp 16 and 11

The **external carotid artery** is to be examined first. It is exposed now in the whole length of its course from its origin at the bifurcation of the common carotid artery at the level of the upper border of the thyroid cartilage to its termination in the parotid gland where it divides into the maxillary and superficial temporal arteries and its branches have been examined at least in parts of their course. The artery is accompanied and ensheathed by a large sympathetic plexus derived from the superior cervical ganglion, and all its branches carry offshoots from it and distribute them to the glands and visceral muscle of the head and neck.

The external carotid artery lies at first on the medial side of the internal carotid artery but as it ascends it crosses over it and gains its lateral side

(Fig. 55). At its commencement and while it lies in the carotid triangle it is comparatively superficial. It is covered there by the skin, the superficial fascia (with the platysma muscle the anterior cutaneous nerve, and the cervical branches of the facial nerve in it), and the deep fascia; and deep to the deep fascia it is crossed by the common facial and lingual veins and the hypoglossal nerve (Fig. 54) *It first runs upwards and forward* and then upwards and backwards towards the angle of the jaw and there, under cover of the lower part of the parotid gland, it is crossed from behind forwards by the anterior branch of the posterior facial vein and the posterior belly of the digastric and the stylo-hyoid muscle. Above the stylo-hyoid muscle it enters the postero-medial surface of the parotid gland, and at its termination behind the neck of the mandible it lies deeply in it and is crossed from behind by the branches of the facial nerve (Fig 43).

The muscular wall of the pharynx lies in contact with the medial side of the artery at its commencement and the internal and external laryngeal nerves are also to be found there The medial relations at a higher level are the structures which intervene between it and the internal carotid artery namely the stylo-pharyngeus muscle, the tip of th styloid process and the stylo-hyoid ligament, the stylo-glossus muscle the pharyngeal branch of the vagus, and the glosso-pharyngeal nerve (Fig 53).

The external carotid artery rapidly diminishes in size owing to the number of large branches given off from it. These branches are the **superior thyroid, lingual, and facial arteries** which arise from its anterior surface and run forwards the **occipital and posterior auricular arteries** which are given off from it behind and run backwards the **ascending pharyngeal artery** which springs from its medial side and *ascends on the wall of the pharynx to the base of the skull* and the **superficial temporal and maxillary arteries** which are its terminal branches (Fig. 53) They have already been examined in great part, but all of them should be reviewed at the present time they are first to be named on Fig 53

The superior thyroid artery arises from the antero-medial surface of the external carotid artery close t its commencement. It lies there t the anterior border of the sterno-mastoid muscle and could easily be reached from the surface; it is, therefore often divided in cut throat wounds. It arches downwards and forwards along the lateral border of the thyro-hyoid muscle, lying superficial t the external laryngeal nerve, and passes below the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles t the apex of the lateral lobe of the thyroid gland to which t distributes it terminal branches (see p. 162). In it course it gives off the following branches (1) The **infra-hyoid artery** *small vessel which runs along the lower border of the hyoid bone beneath the thyro-hyoid muscle and anastomoses with the vessel of the opposit side.* (2) The **superior laryngeal artery** accompanies the nerve of that name beneath the thyro-hyoid muscle and having pierced the thyro-hyoid membrane supplies the muscles, the mucous membrane and the gland of the larynx. (3) The **sterno-mastoid branch** runs down ard and laterally along the pper border of the posterior belly of the omo-hyoid, crosses the carotid heath and sinks into the deep surface of the muscle Frequently it is a separat branch of the external carotid artery (4) The *crico-thyroid artery runs trans ersely across* the upper part of the crico-thyroid membrane and communicates th the

artery of the opposite side; the arterial arch thus formed is to be avoided in the operation of laryngotomy

The superior thyroid vein begins in a plexus on the surface of the thyroid gland and receives branches corresponding more or less t the branches of the artery It usually runs upwards and backwards and joins the lingual or linguo-facial vein but sometimes crosses the upper part of th carotid sheath and opens into the internal jugular vein (Fig 54)

The lingual artery supplies the tongue and the muscles and glands of the floor of the mouth. It arises at the level of the great cornu of th hyoid bone, and its course to the tongue may be di ided into three parts: (1) in the carotid triangle where it is comparatively superficial (p 99); ( ) in the submandibular region where it lies deep to the hyo-glossus muscle (p. 143) nd (3) beyond the anterior border of the hyo-glossus where it divides int its terminal branches, the sublingual and ranine arteries (p. 144)

The lingual veins are described on p. 144

The facial artery arises in the upper part of the carotid triangle close above the lingual artery It passes upward on the surface of the middle and superior constrictors of the pharynx, the latter muscle separating it from the lower part of the tonsil In its course it passes beneath the posterior belly of the digastric and the stylo-hyoid muscle. At the upper border of the stylo-hyoid it enters a deep groove on the posterior end of the submandibular gland and runs almost horizontally forwards in it under cover of the mandible; and after emerging from the groove it bends downwards and turns round the lower border of the mandible t the anterior edge of the masseter muscle, pierces the deep fascia (Fig 50), and passes on to the f ce (p 90). In the cervical part of its course it gives off: (1) The ascending palatine artery which runs between the stylo-glossus and stylo-pharyngeus muscles and turns over the upper border of the superior constrictor of the pharynx and enters the soft palate. (2) The tonsillar artery the chief artery of the tonsil, runs between the internal pterygoid and stylo-glossus muscles (see Fig 43) and then along the side of the pharynx; it pierces the superior constrictor and ends in the tonsil. (3) Branches to the submandibular gland are given off while the artery is in the groove in the gland. (4) The submental artery a branch of some size, arises close to the lower border of the mandible and runs forwards first between the jaw and the gland and then on the surface of the mylo-hyoid muscle. At the chin it turns over the margin of th jaw and ends in branches to the muscles and the skin.

The facial vein crosses the margin of the j w posterior to the artery It has been traced downwards and backwards superficial to the submandibular gland. It joins the anterior branch of the posterior facial vein to form the common facial vein which enters the internal jugular vein at the level of the hyoid bone (Fig 54).

The occipital artery arises from the posterior surface of the external carotid artery opposite the facial artery and close to the lower border of the posterior belly of the digastric muscle the hypoglossal nerve hooks round it at its origin. It runs upwards and backwards under cover of the parotid gland and then runs on th deep surface of the digastric muscle to the deep surface of the mastoid process, crossing the internal carotid artery the vagus nerve the internal jugular vein, and the accessory nerve in its course From the mastoid process it crosses the upper part of the back of the neck and enters the scalp where its terminal branches are distributed (p. 53). It gives off on the front

of the neck: (1) muscular branches and (2) a small meningeal branch which runs on the surface of the internal jugular vein through the jugular foramen. Among the muscular branches are two fair-sized branches to the sterno-mastoid muscle. The lower branch arising from the beginning of the artery or directly from the external carotid artery runs downwards and backwards over the hypoglossal nerve and the carotid sheath; the upper branch arises as the occipital artery crosses the accessory nerve and runs downwards and backwards with it to the muscle.

The posterior auricular artery, smaller than the occipital, arises above the digastric muscle. It is, therefore, deeply placed at its commencement. It runs upwards and backwards on the lateral surface of the stylo-hyoid muscle and passes between the styloid process and the deep part of the parotid gland to reach the groove between the cartilage of the auricle and the mastoid process. There it associates itself with the posterior auricular nerve and is distributed to the scalp (p. 58). In addition to its terminal branches it gives off (1) twigs to the parotid gland and (2) the stylo-mastoid artery which enters the stylo-mastoid foramen, either superficial or deep to the emerging facial nerve and in the interior of the temporal bone supplies the tympanic cavity, the mastoid air cells, and the semicircular canals.

The occipital and posterior auricular veins do not reach the front of the neck; the former vein joins the sub-occipital plexus (p. 59) and the latter vein assists in the formation of the external jugular vein (p. 89).

The superficial temporal and maxillary arteries commence at the bifurcation of the external carotid artery in the substance of the parotid gland at the level of the neck of the mandible. Both have already been described (pp. 58 and 1??).

The ascending pharyngeal artery and the upper parts of the internal carotid artery and the internal jugular vein will be exposed only after the styloid muscles have been reflected from them. In order to gain free access to the muscles the posterior belly of the digastric is to be divided close to its origin and the external carotid artery cut across below the origin of its facial branch; and these structures being displaced, the stylo-pharyngeus muscle, the third of the styloid muscles, can be examined in its whole length, care being taken of the glosso-pharyngeal nerve as it winds round its posterior border and descends on its surface.

The stylo-pharyngeus (Fig. 91) is larger and longer than the other styloid muscles; often it consists of two parts. It arises from the medial surface of the styloid process close to its root and proceeds downwards and forwards between the external and internal carotid arteries to the side of the pharynx; there it passes under cover of the upper border of the middle constrictor muscle. It broadens considerably in the pharyngeal wall, in which some of its fibres end, but, after being joined by the palato-pharyngeus, the greater part is inserted on the posterior border of the thyroid cartilage. It assists in the elevation of the larynx during swallowing and speaking. It is supplied by a branch of the glosso-pharyngeal nerve.

The base of the styloid process is to be snipped through with the bone forceps and, with its three muscles attached to it, it is to be turned

downwards. The **ascending pharyngeal artery** should then be sought on the wall of the pharynx in the interval between the external and internal carotid arteries and followed upwards to the base of the skull if it is not well injected it is difficult to trace

The **ascending pharyngeal artery** is a long slender vessel which arises from the medial side of the external carotid artery close to its lower end It ascends vertically on the wall of the pharynx deep to the stylo-pharyngeus muscle

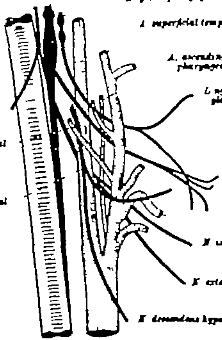


Fig. 53.

A scheme of the relations of the great vessels of the neck and the last four cranial nerves. The branches of the external carotid artery are to be named.

at first in the interval between the external and internal carotid arteries and then on the medial side of the internal artery It gives off in its course (1) **pharyngeal branches**, which supply the muscles and the mucous membrane of the pharynx (2) **palatine branch** which is distributed to the soft palate and the tonsil, and varies inversely in size with the palatine and tonsillar branches of the facial artery; and (3) **muscular branches** to the pre-vertebral muscles. At the base of the skull the artery gives off several small **meningeal branches**, which enter the skull through the foramen lacerum the jugular foramen, and sometimes through the anterior condylar foramen along the hypoglossal nerve.

The **internal carotid artery** is now to be dissected. It commences at the bifurcation of the common carotid artery and ascends vertically through the neck to the base of the skull. There it enters the carotid canal of the temporal bone and, passing through it, reaches the interior of the cranium and is expended there in the supply of the cerebral hemispheres, the eye and its appendages, and the nose, only a few small branches becoming superficial over the lower part of the forehead (Fig. 7 and p.). The cervical part alone comes under notice in the present dissection. Its upper part requires to be carefully cleaned for it is invested by a tough fascia and in this fascia the last four cranial nerves and the upper part of the **cervical sympathetic trunk** are embedded. The **pharyngeal branch of the vagus** which runs downwards and forwards across the surface of the artery should be secured at once and then the trunk of the **glosso-pharyngeal nerve** in the same position at a higher level. The lower parts of the external and internal laryngeal nerves have already been secured; when followed upwards they will be found to arise from one stem, the **superior laryngeal branch of the vagus**, which passes forward deep to the internal carotid artery (*Fig. 53*). The trunks of the last four cranial nerves, the **glosso-pharyngeal, vagus, accessory** and **hypoglossal nerves**, are then to be *followed to the base* of the skull where they lie close together in the interval between the internal jugular vein and the internal carotid artery (*Fig. 53*).

The **internal carotid artery** lies at first in the carotid triangle. There it is comparatively superficial, being covered only by the general investment of the neck, the integument, the fasciae and the platysma, and overlapped by the sterno-mastoid muscle; more intimately however it is overlapped by the ... of the internal jugular vein, the descendens hypoglossi ... the superficial ... is crossed by the hypoglossal nerve, the ... sterno-mastoid branch of the occipital artery and the common facial ... (Fig. 41). At a *higher level it lies much more deeply, for* ... under the lower end of the parotid gland (Fig. 42) and is ... by the posterior belly of the digastric and the stylo-hyoid muscle and ... stylo-pharyngeus ... muscle, arteries which accompany them; and ... these structures is ... by those which intervene between ... and the external carotid artery, namely the pharyngeal branch of the vagus, the stylo-pharyngeus ... the glosso-pharyngeal nerve and the styloid process (Fig.). Posteriorly the artery rests on the pre-vertebral fascia ... the longus capitis muscle in *front of the upper three cervical* vertebrae. The cervical sympathetic trunk descends behind it and the superior laryngeal nerve ... medially posterior to it. On its medial side, closer to it below than ... the wall of the pharynx and the ascending pharyngeal artery ... on its lateral side below but inclining posteriorly ... the internal jugular vein. At the base of the skull the last four cranial nerves ... between it and the vein; the accessory nerve however soon ... back ... the glosso-pharyngeal and hypoglossal nerves run forwards ... while the vagus descends behind its lateral margin.

The internal carotid artery gives off no branches in the neck.

The upper part of the internal carotid artery is frequently tortuous; sometimes, indeed, it forms a complete loop. The tortuosity becomes of importance in the altered relationship that its curves may bear to the tonsil.

The normal straight artery lies on the pharyngeal wall behind and lateral to the tonsil, usually about one inch di tant from it but one of the curves of the tortuous artery may be much closer to it and so close as to be separated from it only by the superior constrictor muscle of the pharyngeal wall.

The Carotid Sinus and the Carotid Body.—The carotid sinus is the dilatation which is present on the commencement of the internal carotid artery; it is usually well circumscribed and confined to the int rnal artery but occasionally it is more diffuse and may include the termination of the common carotid artery and, though more rarely the commencement of the external carotid artery The wall of the sinus is thinner than the wall of the artery above and below it as can be verified by splitting the vessels longitudinally The wall of the sinus especially the anterior wall, is richly supplied with sensory nerves which are in the main, branches of the glosso-pharyngeal nerve The endings of the nerves are stimulated by changes in the blood pressure in the sinus, the changes being amplified by the dilatation; and the pressor receptor mechanism so constituted is comparable in structure to the aortic and right subclavian mecha isms which are supplied by the ortic branches of the vagus nerves. The impulses arising in the sinus act on the principal nuclei of the medulla, especially the vaso-motor cardio-inhibitory and respiratory centres; it shares therefore in the regulation of the general blood pressure.

The **carotid body** is a small reddish brown structure, resembling in size and shape a grain of rice which lies in the angle between the internal and external carotid arteries at their origin. It is easily found in the fresh subject but is not so readily identified in the dissecting room The best means of finding it is to divid the common carotid artery below it bifurcation and carefully turn the upper part upwards until the deep surface of the area of bifurcation is turned t the front the body lies there in or on the adventitia of the artery The body consists of large round cells and is richly supplied by arterial twigs from the carotid arteries; and among the cells are sensory nerve endings derived mainly from the glosso-pharyngeal nerve Its function is not yet fully understood, but in some way it is part of the carotid sinus mechanism; possibly it is a hemo-receptor and is activated by changes in the CO_2 and O_2 content of the blood. Similar structures are present on the right subclavian art ry the arch of the aorta, and the pulmonary artery (see Vol. II)

The **carotid nerve**, the sensory nerve of the carotid sinus and the carotid body is a slender branch of th glosso-pharyngeal nerve which arises near the base of the skull and descends on the surface of the internal carotid artery; it divides into two branches for the two structures. They may also recei e some fibres from th vagus and the cervical sympathetic trunk, but these seem t be of secondary importance

The **internal jugular vein** collects the blood from the brain, the eye and the orbit, the superficial parts of the face, and much of the neck the right vein is usually larger than the left It commences at the base of the skull where it is directly continuous through the posterior part of the jugular foramen with the sigmoid part of the transverse sinus of the cranial cavity infective processes in the sinus thus readily enter the vein. At its commencement there is a bulbar dilatation on the vein called the superior bulb The lumen of the bulb remains constantly patent and always of the same size owing to the attachment of its walls to the margin of the foramen. This is in marked contrast to the

vein proper which collapses and dilates during the respiratory cycle it is emptied and almost entirely collapsed during in piration and then appears as a flaccid ribbon like band and it is fully distended in expiration and nearly half an inch in diameter From its origin the internal jugular vein runs down the neck on the lateral side of the internal carotid artery above and the common carotid artery below being contained with them and the vagus nerve in the carotid sheath (Fig 51) and at the root of the neck behind the medial end of the clavicle it unites with the subclavian vein to form the innominate vein (Fig 8) At and just above its termination there is a spindle-shaped dilatation of the vein much larger on the right side than the left it lies

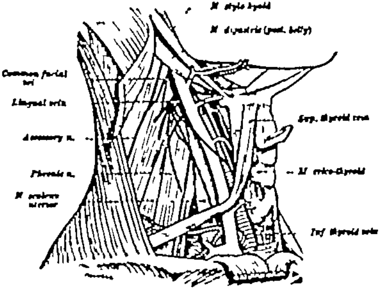


Fig 51
Deep dissection of the side of the neck.

behind the fossa between the two heads of the sterno-mastoid muscle. This is the inferior bulb of the vein At its upper end there is a venous valve which should be examined by slitting the vein it usually consists of two cusps, but they are not competent against, and they yield to, high pressures in the thorax and allow back flow of blood into the vein. The tributaries of the vein are the **inferior petrosal sinus** which joins it at or just below its superior bulb and then, successively the **pharyngeal veins**, the **common facial vein**, the **lingual vein**, and the **superior and middle thyroid veins** (Fig 51)

The upper part of the internal jugular vein is to be carefully cleaned and the relationship of the last four cranial nerves to it is to be established. The **rectus capitis lateralis** muscle on which the vein rests between the

skull and the transverse process of the atlas is to be defined and cleaned, the vein being displaced to allow this to be done. At the medial margin of the muscle the **anterior primary ramus of the first cervical nerve** will be seen it is to be secured and followed downwards to its junction with the second nerve to form the first loop of the cervical plexus (p 101)

The **internal jugular vein** first lies postero-lateral to the internal carotid artery and the last four cranial nerves (Fig 43), but as it descends it takes a more directly lateral position, and its anterior margin even overlaps the internal and then the common carotid artery At the root of the neck, however both veins incline to the right, and there the right vein lies a little distance from the carotid artery and the left vein overlaps it even more. The relations of the internal jugular vein are very much the same as those of the internal carotid artery above and the common carotid artery below with which and the vagus nerve it is enclosed in the carotid sheath; most of the following details, therefore, are but a repetition of the relations of those vessels.

The upper part of the vein lies deep to the styloid process and the stylo-pharyngeus and stylo-hyoid muscles and then is crossed by the posterior belly of the digastric muscle, along the upper and lower borders of which the posterior auricular and occipital arteries run backwards. The accessory nerve running downwards and backwards, passes superficial (occasionally deep) to it at the level of the transverse process of th atlas. The glosso-pharyngeal and hypoglossal nerves pass forwards between the vein and the internal carotid artery At a lower level the vein is covered by the lower end of the parotid gland, but after emerging from under it it lies under cover of the anterior border of the sterno-mastoid muscle, though it may project in front of the muscle in the upper part of the carotid triangle (Fig 54) The surface of the vein is intimately related to the deep cervical lymph glands, which lie for the most part on its lateral side and between it and the sterno-mastoid muscle (p. 108). Under cover of the sterno-mastoid muscle it is crossed by the descendens cervicalis from the cervical plexus, the sterno-mastoid branch of the superior thyroid artery and the omo-hyoid muscle

Posteriorly the vein first rests on the rectus capitis lateralis muscle and the loop between the first and second cervical nerves. Below the atlas it rests on the transverse processes of the cervical ertebræ between the scalenus anterior laterally and the longus capitis medially The ascending cervical artery and the phrenic nerve lie behind it, and crossing the nerve there are the transverse cervical and supra-scapular arteries. On the left side the thoracic duct also lies posterior to it. At the root of the neck the internal jugula vein crosses the first part of the subclavian artery and joins the subclavian vein to form the innominate vein.

The last four cranial nerves emerge from the cranial cavity at the base of the skull and pass through the upper part of the neck to their distribution. The **glosso-pharyngeal, vagus, and accessory nerves** emerge through the jugular foramen in that order from before backwards, and lie between the internal carotid artery in front and the internal jugular vein behind and the **hypoglossal nerve**, having emerged through the anterior condylar foramen, associates itself with them. The nerves retain their common intermediate relationship to the artery and vein for a short distance but then each pursues its own course (Fig 53) The glosso pharyngeal nerve passes forwards and medially superficial

to the internal carotid artery to be distributed to the tongue and the pharynx the accessory nerve passes backwards superficial (or deep) to the internal jugular vein to the sterno-mastoid and trapezius muscles the hypoglossal nerve runs forwards across the internal and external carotid arteries to be distributed to the muscles of the tongue and the vagus nerve proceeds vertically downwards in the carotid sheath. The course relations and distribution of these nerves have now to be studied in detail but in an ordinary dissection it is impossible to follow out many of their smaller branches. It is those branches therefore which the student can dissect for himself that are described in detail below the others are only mentioned.

The glosso-pharyngeal (ninth cranial) nerve contains both motor and sensory fibres, and, as its name implies, it is distributed to the tongue and the

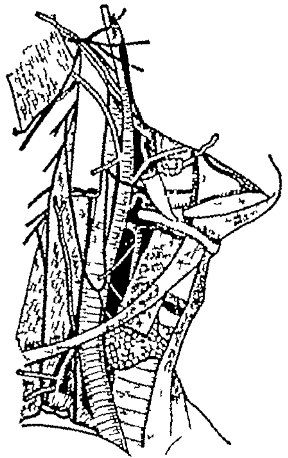


FIG 55 See opposite page

pharynx. Just beyond its exit from the skull, through the jugular foramen, it passes forwards between the internal jugular vein and the internal carotid artery and descends in front of the artery beneath the styloid process and the muscles attached to it At the lower border of the stylo-pharyngeus muscle it turns on to its superficial surf ce and proceeds forwards on it between the internal and external carotid arteries. It then lies on the middle constrictor muscle of the pharynx and passes under the hyo-glossus to the base of the tongue (Fig 51) It terminates there in its lingual branches which supply the mucous membrane of the posterior third of th tongue as nerves of taste and of common sensibility The branches which arise from it in the neck are (1) the nerve to the stylo-pharyngeus; (2) the pharyngeal branches pass to the surface of the middle constrictor of the pharynx and unite there with the pharyngeal branch of the vagus and the pharyngeal branches of the cervical sympathetic trunk to form the pharyngeal plexus. Branches from the plexus supply the muscular wall of the pharynx and the muscles of the palate (except the tensor palati, p. 14., and the palato-glossus, p. 141) and the mucous membrane covering them; (3) tonsillar branches form a plexus over the tonsil from which twigs pass to the mucous membrane of the neighbourhood; (4) the carotid nerve descends on the surface of the internal carotid artery to the carotid sinus and carotid body

(The st dent will not be able to dissect the two ganglia which are present on the trunk of the nerve at the lower margin of the jugular foramen and in

---

Fig. 55.

Deep dissection of the side of the neck. The arteries and veins are to be coloured nd the following structures are to be named :—

Subclavian vein.
Internal j gular vein.
Innominate vein.
Subclavian artery vert bral artery
inferior thyroid artery; ascending cervical rtery
supra-scapular artery
transverse cervical artery
Common carotid artery
Internal carotid artery
External carotid artery superio thyroid artery infra hyoid, crico-thyroid, and sterno-mast id branches.
lingual artery supra hyoid branch.
facial artery ascending palatine and sub-mental branches.
occipital artery sterno-mastoid branches.
posterior ricular artery
ma illary artery
superficial temporal artery
Facial nerv
Accessory nerv
Glosso-pharyngeal nerve.
Hypoglossal nerve descendens hypoglossi descendens cervicalis.
Vagus nerve
Phrenic nerve.
Sterno-mastoid, scalenus anterior omo-hyoid, sterno-hyoid, sterno-thyroid, thyro-hyoid, anterior belly of digastric mylo-hyoid, hyo-glossus, and stylo pharyngeus muscles.
Hyoid bone ricoid cartilage fi st ring f trachea.
Thyroid gland deep part f submandibular gland.

which the sensory fibres arise; nor the communicating branch to the facial nerve; nor the tympanic branch (Jacobson's nerve) which arises from the lower ganglion. This nerve passes into the tympanic cavity and takes part in the formation of the tympanic plexus from which its fibres, or some of them, emerge as the small superficial petrosal nerve. This nerve has already been stated to join the otic ganglion (p. 145) and from there to pass by the auriculo-temporal nerve to the parotid gland as its secreto-motor nerve.)

The **vagus** (tenth cranial) **nerve** passes through the jugular foramen in company with, and in the same sheath of dura mater as, the accessory nerve. It then runs vertically down the neck in the carotid sheath lying behind and between first the internal carotid artery and the internal jugular vein and then the common carotid artery and the same vein. Its relations, therefore, are similar to those of the vessels. At the root of the neck it enters the thorax, on the right side by crossing the first part of the subclavian artery and on the left side by continuing between the common carotid artery and the left subclavian artery; and from the thorax it is continued into the abdomen on the walls of the œsophagus. After emerging from the skull the vagus is joined by the cerebral part of the accessory nerve, which is distributed through its pharyngeal and laryngeal branches, and there is there present on it an elongated ganglion (ganglion nodosum) about three quarters of an inch in length (Fig. 53). The ganglion is loosely connected to the first loop of the cervical plexus and the superior cervical sympathetic ganglion, and, usually, the hypoglossal nerve.

(Above the ganglion nodosum the vagus nerve has a second smaller ganglion on it, the ganglion jugulare. It is connected to the facial and glosso-pharyngeal nerves and gives off a small meningeal branch and an auricular branch (Arnold's nerve). This nerve courses through the temporal bone and is finally distributed to the lower half of the membrana tympani and the skin lining the lower half of the external auditory meatus.)

The **branches** which arise from the vagus nerve in the neck are: (1) The **pharyngeal branch** which rises from the ganglion nodosum and passes downwards and forwards between the internal and external carotid arteries to end in the pharyngeal plexus (Fig. [illegible]). This is a plexus of fine filaments formed on the wall of the pharynx by the pharyngeal branches of the glosso-pharyngeal and vagus nerves and the superior cervical sympathetic ganglion. Twigs from it supply the muscles and the mucous membrane of the pharyngeal wall and most of the muscles of the soft palate. (2) The **superior laryngeal nerve** also arises from the ganglion nodosum and runs downwards and forwards deep to the internal carotid artery (Fig. 53). It ends by dividing into the internal and external laryngeal nerves, both of which have already been dissected. The **internal nerve** enters the larynx by piercing the thyrohyoid membrane under cover of the [illegible] muscle and is distributed to its mucous membrane and the mucous membrane of the epiglottis and the base of the tongue. The **external nerve** is traced to the cricothyroid muscle in which it ends. (3) The **recurrent** (or inferior) **laryngeal nerve** arises differently on the two sides. On the right side [illegible] the vagus nerve crosses the first part of the subclavian artery and hooks round the artery to ascend into the neck. On the left side it springs from the vagus in front of the arch of the aorta and passing under the aorta [illegible] behind the common carotid artery into the neck. In the neck the nerve of each side proceeds upwards in the groove between the œsophagus and the trachea and passes deep to the lateral lobe of the thyroid gland [illegible] the [illegible] in front or behind by the inferior thyroid artery. It then passes under the lower border

of the inferior constrictor muscle of the pharynx (Fig 91) and enters the larynx, to all the muscles of which except the crico-thyroid it is distributed; it also supplies sensory fibres to the mucous membrane of the lower part of the larynx.

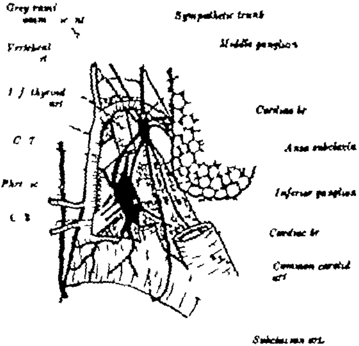
(Two cardiac branches arise from the vagus in the neck, one in the upper and one in the lower part They pass downwards into the thorax usually posterior to the subclavian artery and there join the cardiac plexuses.)

The **accessory** (eleventh cranial) **nerve** is formed of tw parts, a spinal and a medullary as will be seen when the brain is removed. The two parts pass through the jugular foramen as one trunk, in the same sheath of dura mater as the vagus, but just below the base of the skull they again become separate. The medullary part joins the ganglion nodosum of the vagus nerve and is distributed through its branches, contributing the motor fibres to the pharyngeal, superior laryngeal, and recurrent laryngeal nerves. The spinal part passes backwards across (or sometimes deep to) the internal jugular vein and emerges from below the posterior belly of th digastric muscle to reach the sterno-mastoid muscle which it supplies (Fig 55). It pierces the sterno-mastoid and appears at its posterior border in the posterior triangle of the neck, across which it runs to end in the trapezius muscle (Fig 28).

The **hypoglossal** (twelfth cranial) **nerve** leaves the skull through the anterior condylar canal and at first lies medial t the internal jugular vein and the internal carotid artery; as a rule it is intimately connected by fibrous tissue to the vagus nerve round the ganglion nodosum of which it winds to reach its lateral surface It passes forwards between the jugular vein and the carotid artery and descends in that position to the lower border f the posterior belly of the digastric muscle. It then hooks round the lower end of the occipital artery and turns forwards and crosses the external carotid and lingual arteries. Further forwards it passes beneath the digastric tendon and the stylo-hyoid muscle and enters the digastric triangle, in which it disappears beneath the posterior border of the mylo-hyoid muscle. It is the motor nerve to the muscles, intrinsic and extrinsic, of the tongue, and it carries with it fibres from the first cervical nerve which leave it as the descendens hypoglossi, the nerve to the thyro-hyoid and the nerve to the genio-hyoid (Fig. 30). Sometimes, however th vagus nerve receives the communication from the first cervical nerve, and then the descending branch arises from it and is named descendens vagi.

The greater part of the **cervical sympathetic trunk** will have been displayed during the dissection of the neck. It takes a vertical course through the neck lying medial to the vagus nerve in front of the roots of the transverse processes of the cervical vertebræ on the longus capitis and longus cervicis muscles and behind the internal carotid artery above and the common carotid artery below its lower part is also behind the beginning of the vertebral artery (Fig 56) The trunk consists of three ganglia named from their position the superior middle, and inferior ganglia, connected together by an intervening cord or cords. It receives no white rami communicantes from the cervical spinal nerves the fibres which enter it from the spinal cord and have their synaptic endings in its ganglia are derived from the upper thoracic nerves and ascend into it from the thoracic sympathetic trunk with which it

[illegible] continuous below. The branches of the trunk, non-medullated post-ganglionic fibres which have their cell stations in the ganglia, are distributed as follows: (1) As grey rami communicantes to all the cervical spinal nerves and through them to the parts they supply, for example all the [illegible] structures of the arm. ( ) As communicating branches to the ninth, tenth and twelfth cranial nerves and through them to their distribution. (3) A plexus along the internal carotid



F

The middle and inferior [illegible] ganglia [illegible] the [illegible] sometimes [illegible] of the vertebral artery is [illegible]

[illegible] supply the [illegible] the skull and the orbit, for example the dilator [illegible] muscle of the [illegible] (4) As a plexus along the external [illegible] branches to supply the parts they supply, for example the parotid gland and the blood vessels of the face. (5) A plexus [illegible] artery and its branches, especially the [illegible] thyroid arteries. (6) As cardiac nerves which pass down [illegible] the cardiac plexuses and constitute the main sympathetic [illegible] of the heart.

The superior ganglion [illegible] fusiform ganglion about an inch in length which lies [illegible] the transverse processes of the second and

third cervical vertebræ From its upper end the sympathetic trunk is continued upwards into the skull along the internal carotid artery as a well-defined cord or cords, the internal carotid nerve which inside the skull breaks into the internal carotid plexus. The lower end of the ganglion tapers into the cord which connects it with the middle ganglion

The superior ganglion gives branches to the glosso-pharyngeal, vagus, and hypoglossal nerves, and grey rami communicantes to the upper four cervical nerves. The rami pass laterally behind the vagus nerve and between or through the longus capitis and scalenus anterior to reach the spinal nerves; often there is more than one ramus for each nerve. The ganglion gives off plexuses which are distributed along the external carotid artery and its branches and along the internal carotid artery as the carotid nerve There also arise from it a pharyngeal branch which joins the pharyngeal plexus, and the superior sympathetic cardiac nerve which runs downwards behind the common carotid artery into the thorax; the right cardia nerve passes either in front of or behind the subclavian artery and joins the deep cardiac plexus while the left nerve crosses the arch of the aorta and joins the superficial cardiac plexus.

The middle ganglion is the smallest of the ganglia and sometimes appears to be wanting It lies at the level of the sixth cervical vertebra usually in front of or close to the inferior thyroid artery (Fig 56)

The middle ganglion gi es off grey rami communicantes to the fifth and sixth cervical nerves and branches which run along the inferior thyroid artery t the thyroid gland. The middle cardiac nerve, the largest of the cervical sympathetic cardiac nerves also arises from it; it descends into the thorax behind the common carotid artery and joins the deep cardiac plexus.

The inferior ganglion lies deeply in the hollow between the base of the transverse process of the last cervical vertebra and the neck of the first rib In this position it is posterior to the lower part of the vertebral artery which is to be displaced laterally to expose it It is connected to the middle ganglion by two or more cords one of which passes in front of the first part of the subclavian artery the loop thus formed being named the ansa subclavia (Vieussens) These cords having been found the subclavian artery will require to be turned medially the costo-cervical artery being cut in order fully to expose the ganglion. In some subjects it will be seen to be fused with the first thoracic ganglion, there then being formed what is known as the stellate ganglion this condition is usual in many animals

The inferior ganglion sends grey rami communicantes t the seventh and eighth cervical nerves, and gives off plexuses which pass along the subclavian artery and its branches and the inferior cardiac nerve. This nerve passes behind the subclavian artery into the thorax and joins the deep cardiac plexus.

The thyroid gland, one of the ductless glands is most conveniently examined at the present time even though it will by now have shrunk in size probably be displaced from its position, and be much harder

than it naturally is during lif it i a soft lobulated organ, highly vascula an l red lish v ll w in colour It varies much in size even when normal w ghing fr u ne t one and a half or even two ounces, but unless nlarged l y d sease processes which are of common occurrence it ann t be f lt with rta nty from the surface generally it is larger in wom n and in the n nlarged luring menstruation and in pregnancy It is relat ly larger in the hild

Th gland lies in the l w r part of the neck in front and at the sides f th trache It i ymmetric l in general shape but not in details. T pu lly it n i t f tw large lateral lobes united together by a na r w nrel n part named the isthmus. The isthmus connects the low r part f the lat l l bes It u ually vers the second and third

Dia m f the h l l nd in position

ring f tl t l t t t hape nd position in 10) nt f l) t t k t \ ) lat l be f thyroid ul t L l t n l j l t n t uppe borde n l t t) t (l) t l l n ne the l f the middle line n st u ll th l ft t tl l f e) nted process or onnect l t tl l ll l tl nl n rr w trip f muscle the l t al n l l tl l t) l) the n u k m be present en th ugh the) l si t ll lateral lobes re n l masses the bases be ng l n l Tl l l L the les f the la ynx nd t ache t nl L f tl l pe t f th th l rt lage abo e t the fifth th nn f th t he l l the l w nd t thu n the m l l n f th l l Tl e m urements of ash l be re n n l L l l) n w l h nl n th kness at the largest part nl t tl re uch ceeded the gland is

pathologically enlarged the right lobe is generally a little larger than the left lobe The superficial surface of each lobe is full and rounded (Fig 57) it lies under cover of the infra hyoid muscles is crossed by the branches of the ansa hypoglossi to them, and its lower part is overlapped by the anterior border of the sterno-mastoid muscle The medial or deep surface is moulded on the structures on which it lies namely the lower lateral part of the thyroid cartilage the crico-thyroid muscle and membrane the cricoid cartilage and the side of the trachea Usually it extends backwards far enough also to lie against the lateral

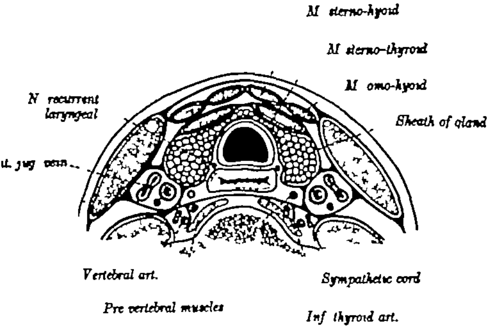


FIG 58

Transverse section of the lower part of the neck to show the relations of the lateral lobes of the thyroid gland. *The layers of the deep cervical fascia are represented diagrammatically*

wall of the lower part of the pharynx (inferior constrictor muscle) and the lateral margin of the oesophagus, especially on the left side the pressure of an enlarged gland on the oesophagus causes *difficulty in swallowing* The recurrent laryngeal nerve ascends in the groove between the trachea and the oesophagus to supply the muscles of the larynx, having a longer course in this position on the left side and it is crossed either in front or behind by the inferior thyroid artery and is then in such intimate relationship with it that the ligation of the artery requires care that the nerve is not injured. The posterior surface of the lateral lobe (Fig 58) rests on the medial part of the carotid sheath generally covering the common carotid artery but leaving uncovered the internal

jugular vein if the gland is enlarged the pulsations of the artery are communicated to it Medial t the carotid heath it is in front of the cervical sympathetic cord The external laryngeal nerve passes deep to the upper end of this surface to reach the crico-thyroid muscle.

The thyroid gland is surrounded by a strong fibro-elastic capsule which sends septa int the gland substance and subdi ide t into masses of irregular siz ; th septa are continuous with the d licat fibrous stroma of the gland. It is further enclosed in a sheath deri ed from the pre tracheal layer of the deep cervical fascia (Fig 58) The sheath is thicker behind than in front; it separates the external and recurrent laryngeal nerves from the gland. The sheath is erywhere ily separated from the capsule xcept on the posterior urface of the isthmus here the t layers are intimately blended. The sheath is firmly attached abo t the thyroid and cricoid cartilages and below to the trachea, the attachments t the cricoid cart lage being by strong bands, espec ially in the middle line hich f rm suspensory ligament for the gland; the ttachment is so firm that the gland follow the larynx in its movements.

The arteries of the gland, markable f r their large size are the superior and inferior thyroid arteries on each side and occasionally a small median vessel, the th roidea ma artery hich ascends in front of the trachea to the isthmus from the innominat artery or the aort or the right common carotid r subclavian art ry The arteries perforat the sheath of the gland, the superior art ry reach ng the pex of the lat ral lobe and the inferior artery ts posterior surface and thus t they break up nt branches. The main branches f the superior art ry are th ee in numb one runs downwards on the t rior borde f the gland nd is continued along the pper margin of the isthmus one passes d ards n the terior surfac nd one on the back part f the de p rfac th supply therefore the pper pole of the lateral lobe and t anterior and medial surfaces and the ppe nd anterior part f the isthmus The branches f the inferior thyroid artery spread er the low pole f th lateral lobe and t posterior surfac an ascending branch n the medial borde f that surfac be ng the largest t anastomoses th the th rd branch f the superior artery Branch re also given t the post rior part f th isthm The bra hes f the rteries freel anastomose th one anothe and form ple n the psule made the bu th and from the ple mon na t ng bra h pass t the substance of the gland, each bra h ppl ng l b l ar f t Th veins form large plexus on the surface f the gland m st b re th medial urfac and from the ple rise th th th roid eins The p rior and m ddle ei join the int rnal jugular in (p) nd the inf rio in joins th innom nat ein (p 94)

The thyro-glossal duct somet mes e the b ing room It is the remnant of th media t f th fl f l phar from hich the gla d partl d lop d It pp nd mall p nt th foramen caec m f the t ngue and f om the be t l l part pers ts t tends siderable distanc low rds t rd the th d gland, passing f nt of the h id bone Somet mall acc ry masses f th id tissue are de eloped from t the us ll l l and ab ut the h id bone

The isthmus of the th i gl nd t be d ided n l h utt g through t ascula n l f scul nos n t l l re t be rem ed The structure f the gland t be mined w th h nd len nd an attempt is t be made to disco er the **parathyroid glands** in t.

The structure of the thyroid gland cannot be studied except on prepared sections, but with a hand lens it is possible to see on sections of dissecting room specimens that it consists of small closed vesicles held together by a stroma of fine fibrous tissue The vesicles are normally not more than 1 mm. in diameter but in one form of disease of the gland are much larger they are filled with a semi fluid colloid substance which will have been coagulated by the preservatives. The colloid substance contains the active principle of the secretion of the gland it itself is probably absorbed by the lymphatics of the gland, which pass to the para tracheal glands (p 109), the deep cervical glands (p. 108), and probably to the thymus gland (Vol. II), while the ctive principle is probably absorbed by the veins.

The parathyroid glands are not easily discovered in dissecting room subjects but they are of such functional importance that a careful search is to be made for them in the positions in which they usually occur; their removal, or disease of them, gives rise to serious disorders of calcium metabolism. They vary in number and position. There are usually two glands on each side, each gland being a flattened oval disc, 6 mm. long and 4 mm. wide reddish brown in colour and not unlike a small lymph gland in appearance. The superior gland is the more constant in position. It generally lies on the middle of the postero-medial border of the lateral lobe of the thyroid gland, embedded in but outside of its capsule proper and within its sheath; it is here close to the postero-lateral margin of the beginning of the oesophagus (Fig 59) The inferior gland usually lies on the lower surface of the lateral lobe of the thyroid gland, sometimes within the sheath and sometimes outside it, but commonly it is t lower level and lies on the side or on the front of the trachea among the inferior thyroid veins; always it is below the loop on the inferior thyroid artery as it reaches the thyroid gland The upper gland is supplied by a branch of the superior thyroid artery or of the anastomosis between it and the inferior thyroid artery and the lower gland by a branch of the inferior thyroid artery (The matter is not yet settled but apparently parathyroid tissue, or tissue closely resembling it, is scattered in small masses through the neck and may actually occur in the substance of the thyroid gland.)

The **cervical part of the trachea** is fully exposed and it and the **cervical part of the oesophagus**, which lies behind it, are to be examined. They both begin at the level of the lower border of the cricoid cartilage in front of the sixth cervical vertebra, and are, of course, the continuations of the larynx nd the pharynx and they pass downwards and slightly backwards through the lower part of the neck into the thorax which they enter when looked at from the front at the lower border of the second thoracic vertebra. The cervical parts of both organs therefore are short.

The trachea or windpipe is a wide tube kept patent by the cartilaginous rings embedded in its wall. It begins at the lower border of the cricoid cartilage, in front of the sixth cervical vertebra, and runs downwards and backwards from the neck into the thorax and ends at the lower border of the fourth thoracic vertebra by dividing into the two bronchi it lies in the middle line in the neck but in the thorax it inclines to the right. Its total length is about 4½ in. and ts transverse diameter about ¾ in. in the male; the measurements are a little less in the female. The length of the part above

the upper border of the manubrium sterni is about 2½ in. when the head is vertical and the face looks forwards; but the trachea can be stretched during life if the head is thrown backwards and its cervical part is then lengthened.

The cartilaginous rings of the trachea are sixteen to twenty in number. Each ring forms about three-quarters of a circle, being deficient behind so that the posterior surface of the trachea, which rests on the oesophagus, is flat; the interval between the ends of the rings is bridged by the fibrous membrane in which the rings are embedded and a considerable amount of involuntary muscle. Each ring is 3 to 4 mm. broad, and is pointed at its ends and often bifurcated; the distance between the rings is less than their width. They are formed of hyaline cartilage but in old age, especially in men, this is commonly irregularly calcified. The framework formed by the rings is so light that the trachea is easily compressed by the neighbouring organs if they are enlarged.

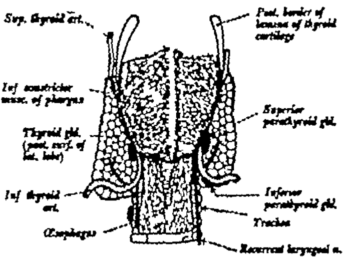


FIG. 50

The posterior surface of the pharynx, oesophagus, and lateral lobes of the thyroid gland; the parathyroid glands are shown in their most common position.

The anterior surface of the cervical part of the trachea is covered, from above downwards, by the suspensory layer of the pre-tracheal fascia which attaches the thyroid gland to the cricoid cartilage, the thyroid isthmus which usually overlies the second, third, and fourth rings, the inferior thyroid veins, which may form a plexus on it, the thyroidea ima artery when it is present, and the thymus gland in children and its remains in the adult; and over it there lie the sterno-thyroid and sterno-hyoid muscles, the pre-tracheal and investing layers of the cervical fascia, and in the latter fascia the transverse branch between the anterior jugular veins. Its sides as low as the sixth ring are in contact with the medial surface of the lateral lobes of the thyroid gland, and below this level are related to the common carotid arteries; and in the grooves between it and the oesophagus are the inferior laryngeal nerves and the terminal part of the inferior thyroid arteries.

The oesophagus or gullet is a muscular walled tube about 10 in. long which extends from the pharynx to the stomach. Its wall is of considerable thickness

(3½ to 4 mm.) and for most of its length in its empty state the front wall is in contact with the back wall the empty oesophagus is thus flattened from before backwards and its lumen nearly obliterated. Its upper end is continuous with the pharynx at the lower border of the cricoid cartilage a level which, measured with a tube passed into it is 6 to 6½ in. distant from the teeth. Its beginning is grasped by the lower part of the inferior constrictor muscle of the pharynx (Fig 59) and is constricted by it so that its lumen when open is about 14 mm. in diameter below the constrictor the lumen is about 20 mm It descends downwards and backwards in the neck, surrounded by loose areolar tissue which facilitates its movements, and it inclines a little to the left side so that at the root of the neck it projects beyond the left margin of the trachea. It rests behind on the pre vertebral fascia in front of the anterior longitudinal ligament of the vertebral bodies and overlapping the longus cervicis muscles (Fig 58) in front of it is the cervical part of the trachea. The lateral lobes of the thyroid gland usually reach so far backwards as to be in contact with it the contact on the left side being greater in extent. The cervical sympathetic trunks and the common carotid arteries lie lateral to its sides, and at the root of the neck it is between the domes of the pleurae the left dome being separated from it by the left subclavian artery The structure of the oesophagus will be examined with the pharynx.

The scalene muscles are now to be studied. They form a group of lateral muscles in the neck (p 9) three in number and from their positions are named anterior medius, and posterior They extend from the transverse processes of the cervical vertebræ to the upper two ribs lying under cover of the sterno-mastoid muscle and projecting beyond it in the floor of the posterior triangle of the neck. The anterior and medius muscles which are attached to the first rib are separated from one another by an elongated triangular interval in which lie the roots of the brachial plexus and the second part of the subclavian artery the posterior muscle even though it is generally inseparable from the medius muscle at its origin, is attached below to the second rib and is therefore easily defined below The lower parts of the three muscles surround the thoracic inlet and support the cervical pleura (the dome of the pleura) and often some muscle fibres, arising from the seventh cervical transverse process are inserted into the supra pleural membrane which invests it (p 117) The scalene muscles are supplied by branches from the anterior primary rami of the lower four or five cervical nerves.

The scalenus anterior arises by a series of slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, and descends almost vertically under cover of the sterno-mastoid muscle; it is inserted by a narrow tendon into the scalene tubercle on the inner border of the first rib and the ridge on its upper surface between the two subclavian grooves. Many of the most important structures of the neck have been described in relation to it for example, the phrenic nerve descends on its surface; the second part of the subclavian artery lies behind it and the subclavian vein in front of it at its insertion; the common carotid artery lies along its attachments to the transverse processes and the internal jugular vein is placed between it and the sterno-mastoid muscle; the roots of the

brachial plexus appear at it lateral border; and it is crossed by the posterior belly of the omo-hyoid muscle and, below it, by the transverse cervical and supra-scapular arteries.

The scalenus medius, the largest of the scalene muscles, arises from the posterior tubercles of the transverse processes of all the cervical vertebræ except the first, and is inserted on a rough impression on the medial part of the upper surface of the first rib which extends between the tubercle of the rib and the groove for the subclavian artery. Some of its fibres end in the fascia covering the dome of the pleura. It forms part of the floor of the posterior triangle of the neck below and in front of the levator scapulæ (Fig. 4), and on its surface there the brachial plexus and the third part of the subclavian artery were dissected; and piercing it there have been found the nerve to the rhomboids and the upper parts of the long thoracic nerve.

The scalenus posterior is the smallest of the three scaleni. It arises from the posterior tubercles of the transverse processes of the lower two or three cervical vertebræ and is inserted into the upper border of the second rib behind the attachment of the serratus magnus.

The Action of the Scaleni Muscles.—The scalene muscles may act from above or below. Acting from above they elevate the thoracic inlet as is required in forced inspiration, and acting from below they bend the neck forwards when both sides contract and bend it to the side when the muscles of one side act alone.

In the interval between the transverse process of the atlas and the under surface of the skull and behind the commencement of the internal jugular vein, the **rectus capitis lateralis**, a small rectangular muscle belonging to the pre-vertebral group of muscles, is to be defined.

The rectus capitis lateralis arises from the upper surface of the transverse process of the atlas and is inserted into the under surface of the jugular process of the occipital bone immediately behind the jugular foramen. The anterior ramus of the first cervical nerve, which supplies it, emerges at its medial border and passes downwards behind the internal jugular vein to join the second nerve and form the first loop of the cervical plexus.

REMOVAL OF THE SPINAL CORD AND THE BRAIN

The further dissection of the head and neck can be carried out only after the spinal cord has been removed from the vertebral canal and the brain from the cranial cavity. The dissections are not difficult while they are being carried out the external membranes of the cord and the brain are to be examined.

1 The removal of the spinal cord requires that the vertebral canal be opened from behind. The first step in this dissection, and one which must be thoroughly carried out, is to strip the spinous processes and the vertebral laminæ on both sides of all the muscle fibres attached to *them*; the vertebral arches must be cleanly exposed. The muscles must also be completely removed from the back of the sacrum and it is advisable to define the lower opening of the sacral canal. Some of

the posterior rami of the spinal nerves should be retained The vertebral laminæ are now to be sawn through from the third cervical vertebra to the lower opening of the sacral canal the atlas and the axis are to be left intact to be studied with the atlanto-occipital joints. The following directions are to be strictly attended to The laminæ must be cut close to the medial side of the articular processes the saw must be held so that it slants medially the head should hang over the table to stretch the cervical region, and blocks should be placed under the body as they are required to flex the other regions there will be difficulty in the lumbar region and here it is easier to use the mallet and chisel than the saw on the sacrum care requires to be taken to open the vertebral canal and not to saw through the whole thickness of the bone. The laminæ and spinous processes connected together by the ligamenta flava and the supra spinous and inter-spinous ligaments are to be removed in one piece it is to be laid aside wrapped in a moist cloth, for a later study of the vertebral column and its joints as a whole.

In the vertebral canal the **dura mater of the spinal cord** is exposed Between it and the walls of the canal there is a quantity of loose areolo-fatty tissue it is most abundant in the sacral region. This tissue contains a series of **venous plexuses** and a number of small **spinal arteries**. They cannot be examined in any detail but the dissector should understand their general arrangement for they are important in injuries of the back and in operations on the spinal cord.

The **internal vertebral venous plexuses** extend the whole length of the vertebral canal, that is, from the foramen magnum to the sacrum they lie in the interval between the walls of the canal and the dura mater of the spinal cord The veins which form them have a general longitudinal direction but they anastomose freely with one another by transverse branches especially opposite the vertebræ where there are anastomotic rings round the vertebral canal. There are two sets of main veins on the anterior wall and two sets on the posterior wall of the canal, the anterior and posterior plexuses; the veins of the anterior plexuses are the larger The **anterior plexuses** lie on the posterior surface of the bodies of the vertebræ and the intervertebral discs they cannot be seen at present. The two sides are freely connected by transverse veins which pass in front of the posterior longitudinal ligament and there receive large veins from the bodies of the vertebræ. The **posterior plexuses** lie one on each side of the middle line on the deep surface of the laminæ and ligamenta flava; they communicate freely through the ligaments with the posterior external vertebral plexuses (p. 84)

The plexuses are drained by the **intervertebral veins** which pass with the nerve trunks through the intervertebral foramina and join the vertebral, intercostal, lumbar and lateral sacral veins; and they communicate above with the sub-occipital plexuses and the intra-cranial venous sinuses round the foramen magnum.

The **spinal arteries** are series of small vessels which enter the vertebral canal through the intervert bral foramina. In the cervical region they are deri ed from the vertebral artery and the ascending cervical artery in the thoracic region from the posterior branches of the intercostal arteries, in the

brachial plexus appear at its lateral border; and it is crossed by the posterior belly of the omo-hyoid muscle and, below it, by the transverse cervical and supra-scapular arteries.

The **scalenus medius**, the largest of the scalene muscles, arises from the posterior tubercles of the transverse processes of all the cervical vertebræ except the first, and is inserted on a rough impression on the medial part of the upper surface of the first rib which extends between the tubercle of the rib and the groove for the subclavian artery. Some of its fibres end in the fascia covering the dome of the pleura. It forms part of the floor of the posterior triangle of the neck below and in front of the levator scapulæ (Fig. 4), and on its surface there the brachial plexus and the third part of the subclavian artery were dissected; and piercing it there have been found the nerve to the rhomboids and the upper parts of the long thoracic nerve.

The **scalenus posterior** is the smallest of the three scaleni. It arises from the posterior tubercles of the transverse processes of the lower two or three cervical vertebræ and is inserted into the upper border of the second rib behind the attachment of the serratus magnus.

The Action of the Scaleni Muscles.—The scalene muscles may act from above or below. Acting from above they elevate the thoracic inlet as is required in forced inspiration and acting from below they bend the neck forwards when both sides contract and bend it to the side when the muscles of one side act alone.

In the interval between the transverse process of the atlas and the under surface of the skull and behind the commencement of the internal jugular vein, the **rectus capitis lateralis**, a small rectangular muscle belonging to the pre-vertebral group of muscles, is to be defined.

The **rectus capitis lateralis** arises from the upper surface of the transverse process of the atlas and is inserted into the under surface of the jugular process of the occipital bone immediately behind the jugular foramen. The anterior ramus of the first cervical nerve, which supplies it, emerges at its medial border and passes downwards behind the internal jugular vein to join the second nerve and form the first loop of the cervical plexus.

REMOVAL OF THE SPINAL CORD AND THE BRAIN

The further dissection of the head and neck can be carried out only after the spinal cord has been removed from the vertebral canal and the brain from the cranial cavity. The dissections are not difficult; while they are being carried out the external membranes of the cord and the brain are to be examined.

1. **The removal of the spinal cord** requires that the vertebral canal be opened from behind. The first step in this dissection, and one which must be thoroughly carried out, is to strip the spinous processes and the vertebral laminæ on both sides of all the muscle fibres attached to them; the vertebral arches must be cleanly exposed. The muscles must also be completely removed from the back of the sacrum and it is advisable to define the lower opening of the sacral canal. Some of

It is improbable that the arachnoid mater will have remained intact but there will be sufficient of it to show that it forms a loose tubular sheath for the cord. It is an extremely delicate transparent membrane composed of interlacing fibro-elastic bundles. It is continuous above with the arachnoid of the brain and is carried laterally over th nerve roots, formi g for each root a t bular sheath; and it end at the l vel of the second piece of the sacrum by blending with the filum terminale The wide interval between the arachnoid and the pia mater is the **sub-arachnoid space** (Fig 60). It is widest below where it envelops the end of the spinal cord and the nerves that proceed from it; bove it is continuous with the cranial sub- ra hnoid space It i partially subdivided by three incomplete sept One of these the sub-arachnoid septum connects the pia on the posterior surface of the cord w th the dura mater It is cribriform above but more complet in the thora ic region it may carry blood vessels. The other septa are the ligamenta denticulata which spread out from each side of the cord (Fig 60) The

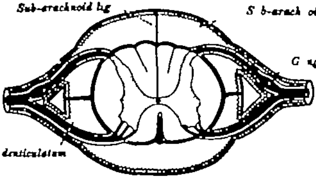


FIG 60.

A transv rse section of the spinal cord and its membranes. The d ra is the hea y outer line the rachnoid is waved, and the pia closely invest the cord. Each root f the spinal nerve carries separat covering f the meninges. The meninges are to be named.

sub-arachnoid space is filled with cerebro-spinal fluid which as a fluid cushion supports the cord and the roots of the nerves.

The pia mater is a vascular fibrous membrane which closely invests, and is firmly adherent to, the cord and is continued into its anterior fissure. It also gives loosely fitting sheaths to th roots of the spinal nerves. It consists of two layers, an outer denser less vascular layer and n inner looser layer in which the blood vessels ramify before they enter the substance of the cord; the blood vessels carry extensions of it into the cord with them. It is continuou above with the pia mater of the brain, which lacks however it outer layer At the lower end of the cord it is prolonged as the filum terminale, a long slender filament which descends among the lower spinal nerves and, having pierced the arachnoid and dura mater is prolonged t the back of the coccyx The pia is thickened along the mouth of the anterior fissure of the cord nd forms a glistening band the linea splendens, and the ligament denticulat are thickenings at the sides of the cord.

The ligamenta denticulata are thin shelf lik fibrous bands t the sides of the spinal cord. The medial border of each band is attached to the pia

l mbar region from the lumbar arteries, nd in the sacral region from the lateral sacral arteries. They supply the bony walls of the vertebral canal, its periosteum and it ligaments, the membranes of the pinal cord, and the substance of the cord itself The branches to the cord perforate the dura mater with the spinal nerves. It is not likely that the dissector will be able to find more than the main arteries.

The dura mater of the spinal cord is to be examined. It is the outermost of the three coverings or meninges which envelop the cord, the innermost meninx being the pia mater and the intermediate the arachnoid mater These membranes are directly continuous with the membranes of the brain. The dura mater requires little cleaning but three or four of the prolongations from it over the spinal nerves into the intervertebral foramina are to be exposed by removing the necessary bone with the bone forceps.

The pinal dura mater forms a wide loose sheath round the spinal cord and the roots of the spinal nerves. It extends from the foramen magnum bove to the level of the second piece of the sacrum below; it is wider in the cervical and lumbar regions It consists of dense fibrous tissue, sparingly supplied with blood vessels, and i rough externally but smooth and shining on its internal surface will be seen when it is opened. It is attached above round the circumference of the foramen magnum and to the bodies of the second and third cervical vertebræ while in the lumbar region fibrous slips connect it to the posterior longitudinal ligament of the vert bral column; it is unconnected t the vertebral arches and the ligamenta flava. In the sacral canal it narrows rapidly and end opposit the second vertebra by blending with the filum terminale which issues through it and descends to the back of the coccyx. The dura mater is prolonged over the roots of the spinal nerves in the form of t bular sheaths which are carried into the intervertebral foramina (Fig 60). These prolongations are short in the upper part of the vertebral canal but become much longer below Apart from the attachments described, which do not interfere with the movements of the column, the dura mater is separated from the wall of the vert bral canal by a space which contains loose areolo-fatty tissue and the vertebral venous plexuses

A small median incision is to be made in the dura mater with a knife, care being taken not to perforate the thin transparent arachnoid mater which lies immediately below it. Th whole length of the dura is then to be slit with scissors and the sub-dural space, the capillary interval between the dura and the arachnoid thu pened The deep surface of the dura will be seen to be smooth, moist with a serous fluid and shining, and it is to be noted that as seen from this surface, the two roots of each spinal nerve perf rate it separately The tubular sheath of dura mater round the spinal nerve, previously exposed from the outside, is therefore doubl and its two parts may be demonstrated by removing the fibrous tissue which binds them together They will then be seen to remain separate as far as the ganglion on the posterior root and there to blend with one anothe (Fig. 60). The arachnoid mater and the pia mater are to be examined.

first of which leaves the vertebral canal between the occipital bone and the atlas and the eighth below the seventh cervical vertebra there are twelve thoracic, five lumbar and five sacral nerves, each of which leaves the vertebral canal below the vertebra with which it corresponds in number and there is one coccygeal nerve. The cord is conventionally divided into cervical thoracic lumbar and sacral regions which correspond to the attachments of the nerves.

A part of the thoracic region of the spinal cord, two or three inches in length is to be removed from the vertebral canal with the membranes covering it the spinal nerves attached to it being divided as far out as possible in the intervertebral foramina. The dura mater of the specimen is to be slit along the middle line in front and the arachnoid cleared away The mode of formation of the spinal nerves can then be studied (Fig. 61) Each spinal nerve springs from the cord by two roots, an anterior or ventral root composed of outgoing or motor fibres and a

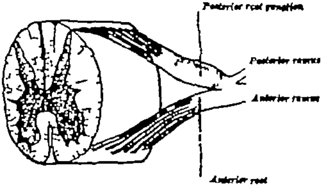


FIG 61

Diagram of the formation of the spinal nerves.

posterior or dorsal root formed of ingoing or sensory fibres. The posterior root is the larger only in the first cervical nerve is it smaller and there indeed, it is sometimes absent. The roots consist of several (five to eight) bundles of nerve fibres which spread out from one another as they approach the cord and especially in the cervical and lumbar regions, are attached in almost unbroken rows. The posterior rootlets or fila as the bundles are named are attached to the spinal cord along a continuous straight line and at the bottom of a slight groove the anterior rootlets, on the other hand, are not regularly placed but emerge from the cord irregularly over an area of some width. The two roots pierce the dura mater separately The dura mater sheath is to be cut away The posterior root will then be seen to have an oval swelling the spinal ganglion (posterior root ganglion) on it immediately beyond the ganglion the two roots unite to form the spinal nerve.

The spinal cord being so much shorter than the vertebral canal, the lower nerve roots have to descend a considerable distance within the

mater in a continuous line between the anterior and posterior nerve roots, but the lateral border is widely serrated and forms a series of tooth-like processes which, carrying the arachnoid with them, are attached to the dura mater. There are usually twenty-one processes, the first of which is attached at the foramen magnum and the others in the intervals between the spinal nerves; the last process is attached below the last thoracic nerve. The ligaments assist in maintaining the cord in the middle of the tube of dura mater.

The general anatomy of the spinal cord is to be studied while it still lies in the vertebral canal. It is a cylindrical structure, slightly flattened in front and behind and much smaller than the canal which contains it. It extends from the level of the *foramen magnum*, where it is continuous with the medulla oblongata of the brain, to the lower border of the first or the upper border of the second lumbar vertebra: the lower level is more common in women and occurs in about 45 per cent. of them. The end of the cord is slightly raised when the thoracic curve is increased as by bending forwards. Its average length is 18 in. in the male and 17½ in. in the female: it is about six tenths of the length of the vertebral column. Its average weight when stripped of its membranes is about 1 oz.

The lower end of the cord tapers rapidly and comes abruptly to a pointed end. The tapered part is named the **conus medullaris**; from its apex a slender filament, the **filum terminale**, is prolonged to the dorsal surface of the coccyx. The greater part of the thoracic portion of the cord is uniform in size and almost circular on transverse section, but in the cervical region and opposite the attachment of the lumbar nerves it is enlarged, especially transversely; the swellings are named the **cervical and lumbar enlargements**. The cervical swelling is the more pronounced; it extends from the third cervical to the second thoracic vertebra and carries the attachments of the nerves of the upper limbs. The lumbar enlargement has the nerves of the lower limbs attached to it; it begins at the level of the ninth thoracic vertebra and reaches its maximum size opposite the last thoracic vertebra; the cord tapers into the conus medullaris below it.

The filum terminale is a glistening thread-like filament which is prolonged downwards from the apex of the conus medullaris. Its upper part is contained within the sheath of dura and arachnoid mater and is surrounded by the roots of the lower spinal nerves. At the level of the second piece of the sacrum it pierces the arachnoid and dura, which end there, and receives a covering from them; its external part extends to the back of the first piece of the coccyx, where it ends by blending with the periosteum. The filum consists mainly of fibrous tissue continued from the pia mater. The central canal of the spinal cord, however, is prolonged into it for about 2 in., and a few nervous filaments can be detected in its substance and on its surface for a like distance.

There are thirty-one pairs of spinal nerves attached to the spinal cord. They are grouped in five sets, cervical, thoracic, lumbar, sacral, and coccygeal, according to the vertebræ with which they are associated and between which they emerge. There are eight cervical nerves, the

first of which leaves the vertebral canal between the occipital bone and the atlas and the eighth below the seventh cervical vertebra there are twelve thoracic, five lumbar and five sacral nerves, each of which leaves the vertebral canal below the vertebra with which it corresponds in number and there is one coccygeal nerve. The cord is conventionally divided into cervical, thoracic lumbar and sacral regions which correspond to the attachments of the nerves.

A part of the thoracic region of the spinal cord, two or three inches in length is to be removed from the vertebral canal with the membranes covering it the spinal nerves attached to it being divided as far out as possible in the intervertebral foramina. The dura mater of the specimen is to be slit along the middle line in front and the arachnoid cleared away The mode of formation of the spinal nerves can then be studied (Fig 61) Each spinal *nerve springs from the cord by two roots*, an anterior or ventral root composed of outgoing or motor fibres and a

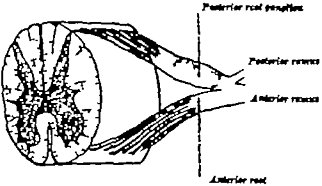


FIG 61

Diagram of the formation of the spinal nerves.

posterior or dorsal root formed of ingoing or sensory fibres. The posterior root is the larger only in the first cervical nerve is it smaller and there indeed it is sometimes absent The roots consist of several (five to eight) bundles of nerve fibres which spread out from one another as they approach the cord and especially in the cervical and lumbar regions, are attached in almost unbroken rows. The posterior rootlets or fila a the bundles are named, are attached to the spinal cord along a continuous straight line and at the bottom of a slight groove the anterior rootlets on the other hand are not regularly placed but emerge from the cord irregularly over an area of some width. The two roots pierce the dura mater separately The dura mater sheath is to be cut away The posterior root will then be seen to have an oval swelling the spinal ganglion (posterior root ganglion) on it immediately beyond the ganglion the two roots unite to form the spinal nerve.

The spinal cord being so much shorter than the vertebral canal, the lower nerve roots have to descend a considerable distance within the

2·5 cm long and ·5 cm. wide. It continues to grow in size after birth but is closed by the spread of ossification into it some time about the middle of the second year

The bones of the vault are much thicker at the end of the first year but are still homogeneous in structure; at the end of the second year however, the outer and inner tables begin to be differentiated and the diploë to appear between them. The tables consist of compact bone and each table is covered on its free surface with periosteum. The diploë is a highly vascular cancellous tissue, the venous channels of which it chiefly consists being particularly large and becoming larger with age; and after thirty years of age their size is so increased and the bone around them so much absorbed that they appear as tortuous markings on X ray plates (Plate I). The diploic veins are freely connected to the intra-cranial venous sinuses, and may be a reservoir for them, and they are also linked with the veins of the scalp (p. 60). The arterial blood supply of the calvarial bones is almost entirely from the meningeal arteries but over the areas of muscle attachment branches of the muscular arteries enter the outer table

The margins of the bones, having grown by the extension of ossification into the surrounding membranes, meet one another during the first year and form the sutures. The membranes which filled the earlier intervals between the bones are thus reduced to thin bands, the sutural ligaments, connecting the periosteum on the outer and inner surfaces (p. 61). The two frontal bones normally begin to unite with one another during the second year and, the suture between them gradually being obliterated, their union is complete about the eighth year In about 12 per cent of Irish subjects, however, the bones fail to unite and the suture between them known as the metopic suture persists. The closure of the other sutures of the vault is much more uncertain. It begins on the inside in most skulls about thirty years of age, and most often first at the back part of the sagittal suture and the lower end of the coronal suture; and the process is generally far advanced before it appears on the outside some time after forty years of age.

It will be noted at once on its removal that the **deep surface of the vault of the skull** is devoid of periosteal investment, for the internal periosteum of the skull although fully functional as a periosteum, and indeed as the main source of the blood vessels of the bones, is inseparably fused with the underlying dura mater proper and is described to take part in its formation (see below) The **groove for the superior sagittal sinus** lies in the middle line and on each side of it there are usually some small circular excavations of the bone if the skull-cap is held to the light it is so thin at these parts as to be almost transparent. The excavations are produced by the **arachnoid granulations** (Pacchionian bodies) which appear to have eaten away the bone for their lodgement. These bodies may be seen on the exposed part of the dura mater particularly in old subjects they are irregular fleshy-looking bodies whose structure will be better understood when the dura mater is raised On the sides of the vault are the branching grooves, directed upwards and backwards, for the **middle meningeal vessels**.

The cranial dura mater, a dense inelastic fibrous membrane, consists of two layers which are firmly adherent to one another The outer layer is the

internal periosteum of the skull bones while the inner layer i comparable to the dura mater of the spinal cord and is the true covering of the brain The layers may therefore be named the **periosteal layer** and the **cerebral layer** The two layers separate from one another at some places to form the walls of the large venous channels named the cranial sinuses and at others that the cerebral layer may form supporting folds or partitions which pass between parts of the brain (Fig. 62) The meningeal vessels lie in the outer layer of the dura close to its surface The dura has a considerable sensory nerve supply derived chiefly from the trigeminal nerve; but there are probably also branches from the vagus nerve

The dura mater is much more firmly attached to the bones of the base than the vault of the cranium, where in the adult at least it i firmly attached only along the lines of the sutures in the child and again in old age it is more firmly adherent. The looseness of the attachment to the vault allows considerable quantities of blood to collect between it and the bones in extra-dural hæmorrhage. The dura is also firmly attached to the margins of the foramina of the skull and it gives coverings to the cranial nerves as they pass through them.

It is the surface of the **periosteal layer of the dura** that is exposed. It is rough due to the fibrous processes which connect it to the bones and the small arteries and veins which it supplies to and receives from them the vessels have been torn in the removal of the skull-cap and appear on the dura as small bleeding points In the middle line of the dura a cranial venous sinus the **superior sagittal sinus**, can be recognised. It is to be opened to exhibit its size and shape the manner of its formation can be understood by reference to the structure of the dura (Fig 62) The **middle meningeal artery** can be recognised on each side It ascends and branches freely It lies in the outer layer of the dura and in addition to supplying the membrane it gives off as its main branches the nutrient arteries of the cranial bones. The branches of the artery are accompanied by venous channels which lie external to them.

The dura mater is to be incised on each side of the superior sagittal sinus from the frontal bone in front to the occipital bone behind the head is best to be raised on a block. The lat ral flaps of dura mater thus defined are to be divided transversely about the middle and the four flaps formed are to be turned downwards over the cut edge of the skull. It will be noted that the deep surface of the dura is smooth and shining it is, of course the deep surface of the cerebral dura mater or dura mater proper A large part of the surface of the brain covered by the **arachnoid mater** will be exposed. The space which has been opened into between the dura and the arachnoid, the **sub-dural space**, is a mere cleft it contains a small quantity of serous fluid sufficient to moisten the opposed surfaces.

The **superior sagittal sinus** is to be slit open in its whole length from behind forwards. Its position in the dura mater which forms its walls, can be seen in Fig 62 it lies between the two layers, its roof being

formed by the periosteal layer and its converging sides by the cerebral layer which is inflected to form the falx cerebri

The **superior sagittal sinus** commences anteriorly in a small vein-like part which lies in the foramen caecum between the crista galli of the ethmoid bone and the frontal bone; it communicates there with the veins of the frontal sinus and in young children and sometimes in adults, with the veins of the nose. It runs backwards in the middle line, grooving the cranial bones, to the internal occipital protuberance and there deviates to one side, usually the right, and becomes continuous with the transverse sinus. Its lumen is triangular in section, small in front but much larger behind, and is crossed by numerous small tendinous cords. Opening into the sinus on each side there

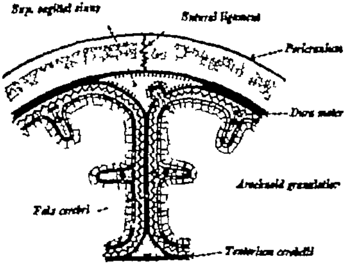


FIG. 62.

A diagram of a vertical transverse section through the skull to show the arrangement of the dura mater and its processes and the formation of the cranial sinuses; the sinuses are lined with endothelium. The sub-dural and sub-arachnoid spaces are to be noted

are a *number of irregular spaces, named lacunae laterales*. They are blood-spaces in the dura mater and receive chiefly diploic veins; and like them they increase in size with age and often produce shallow depressions on the skull. The largest lacuna overlies the upper end of the motor area of the brain; it is, therefore under the post-coronal depression on the surface of the skull (p. 21). The sinus receives as tributaries the veins from the upper surface of the cerebral hemisphere (superior cerebral veins). There are some ten to fifteen of them on each side and it is to be noted that their terminal parts are directed *forwards and, passing beneath the lacunae if they lie in their course,* open into the sinus in the direction opposite to the flow of blood in it. The sinus also receives numerous small veins from the cranial bones and two veins from the pericranium through the parietal foramina (parietal emissary veins). Some arachnoid granulations will almost certainly be seen projecting into the sinus and its lacunae.

The superior sagittal sinus is a typical cranial venous sinus and its chief characters are (1) Its walls are formed by rigid dura mater and are not dilatable or collapsible like th walls of a ein (2) it l lined with a layer of endothelium, comparable to the endothell m of a vein (3) it does not possess valves; (4) its cavity is crossed by tendinous cords, which will favour the clotting of the blood in it (5) it is in open communication with lateral lacunae and through them with the diploic veins; and (6) arachnoid granulations project into it.

The medial strip of dura mater is to be raised on each side from the brain and its edges turned towards the middle line the superior cerebral veins being divided the forward course of the terminal parts of the veins in the wall of the sinus, often for as much as half an inch is to be demonstrated The upper parts of the cerebral hemispheres are then to be displaced sidewards from the middle line to expose the **falx cerebri**, a reduplication of the cerebral layer of the dura mater which passes between them (Fig 6?) It i not possible now to define the attachments of the falx but as much a possible of its surfaces is to be exposed its position between the hemispheres, its narrow width in front and its greater width behind and its sickle shape can be seen

The narrow anterior part of the falx cerebri is to be cut through immediately behind the crista galli and it is to be pulled backwards. The upper surface of the cerebral h mispheres is now fully exposed and between them the great longitu linal fissure which was occupied by the falx. In the free edge of the falx there is a small venous sinus, the **inferior sagittal sinus** it runs along its whole length from before backwards.

The brain is now to be removed If it has been properly injected it is easy to remove it entire but if it has become too hard the mid brain must be divided to allow it to be removed in two parts this alternative, however is not to be resorted to unless it is absolutely necessary

The neck is to be raised on a block and the head allowed to hang well backwards over the end of the table. The anterior parts of the hemispheres will probably of themselves fall away from the orbital plates of the frontal bone but if not they are to be gently raised with the handle of the knife The **olfactory bulbs** which lie on the cribriform plates of the ethmoid bone and receive the **olfactory nerves** on their under surface are to be raised with them frequently however this is not possible as they remain bound to the bone and the **olfactory tracts** which run backwards from them are torn. The hemispheres are to be pulled still farther back until the **optic nerves** emerging from the optic foramina are clearly exposed they are to be cut across about a quarter of an inch behind the foramina. The **internal carotid arteries** which lie close to the lateral sides of the optic nerves are to be similarly treated. In the middle line the **infundibulum**, the slender **stalk of the pituitary gland**, if it is not already broken will now be seen as it passes from the base of the brain into the sella turcica in which the pituitary gland is lodged. If necessary it is to be divided. The oculo-motor (third cranial)

nerves will then come into view and are to be severed close to the anterior clinoid processes. The **trochlear** (fourth cranial) **nerves** usually break of themselves. The head must now be turned well round first to one side and then the other to allow the side and back parts of the hemisphere to be raised from the back parts of the petrous temporal bones: some small veins passing from the under surface of the brain into the dura mater have usually to be divided to allow this to be done. A broad sloping membrane will now be seen extending backwards from the petrous bones between the cerebral hemispheres above and the cerebellum below. It is the **tentorium cerebelli**, a fold of the dura mater. It has a free curved anterior border which bounds an opening through which the mid brain passes and a peripheral border attached laterally to the side wall of the skull. It is to be divided close to its lateral attachment from in front as far back as possible, first on one side and then on the other, care being taken not to injure the cerebellum. The brain will itself now fall backwards, and the pons and medulla will be drawn off the base of the skull and the nerves attached to them will come into view. The **trigeminal** (fifth cranial) **nerves** are to be cut close to the points at which they pierce the dura mater and, continuing backwards, the **facial** (seventh) and **auditory** (eighth) **nerves**, the **glosso-pharyngeal** (ninth) **vagus** (tenth) and **accessory** (eleventh) **nerves**, and the **hypoglossal** (twelfth) **nerves** are to be severed close to the foramina at which they make their exit from the skull. The **abducent** (sixth) **nerves** usually break of themselves. The **vertebral arteries** and the **spinal cord** are then to be divided through the foramen magnum as far down as possible with a long bladed knife, and by manipulating the cerebellum past the cut edges of the tentorium cerebelli, the head hanging well over the end of the table, the whole brain may be delivered from the skull. It is to be laid base upwards in a jar of preserving fluid, on the bottom of which there is some tow or cotton wool, that it may be more fully hardened for dissection.

The head is to be supported on a block so that the floor of the cranial cavity looks upwards. The **falx cerebri** and the **tentorium cerebelli**, and with them a much smaller vertical fold below the tentorium, the **falx cerebelli**, are to be examined while they are still fresh, replacing them in position as is required. These folds are reduplications of the cerebral layer of the dura mater: they pass between the major parts of the brain and separate them from one another, and at the same time they subdivide the cavity of the skull. They are also to be examined on a dried preparation of them in which they are in position.

The falx cerebri, so named from its sickle shape, is a highly arched partition which descends vertically in the interval between the cerebral hemispheres. It is narrow in front where it is attached to the crista galli of open int the sinus that m ch broader behind where it is attached in the sinus also receives sloping upper surface of the tentorium cerebelli. The from the pericranium t is the thinnest and in old people is often perforated. Some arachnoid granul deposits of bone in its substance. The superior sagittal sinus and its lacunae. pper attached margin, the inferior sagittal sinus runs

along its free lower margin, and the straight sinus lies along its attachment to the tentorium.

The tentorium cerebelli is a transversely placed tent like partition of dura mater which, roofing the posterior fossa of the skull, intervenes between the cerebellum below and the hinder parts of the cerebral hemispheres above It is pulled upwards, as it were, by the falx cerebri which is attached to it above so that it slopes downwards and laterally from th middle line to each side. Its peripheral ttached border runs horizontally round the skull, being fixed to the occipital bone behind and on each side in front of it along the superior border of the petrous part of the temporal bone Its anterior free border is concave and bounds the opening which is occupied by the mid brain. At the apex of the petrous part of the temporal bone the free and attached borders cross one another and are continued forwards as ridges to be attached to the anterior and posterior clinoid processes; they enclose a triangular area in which the oculo-motor nerve enters the cerebral layer of the dura mater

The falx cerebelli (Fig 63) is a small median vertical fold of dura mater which lies below the tentorium and projects forwards between the hemispheres of the cerebellum. *Its posterior margin is attached to the internal occipital* crest and its upper edge to the under surface of the tentorium; its lower part frequently divides into two small folds which are lost on the sides of the foramen magnum

THE BASE OF THE SKULL

There are two special studies the stud.nt has to make in the examination of the base of the skull which he is now to undertake namely (1) the position and arrangement of the **cranial venous sinuses**, and ( ) the course of the intra-cranial parts of the **cranial nerves** and the position of the foramina through which they make their exit from the skull. The two studies are best combined and carried out as each cranial fossa is examined There also fall to be studied the **meningeal arteries**, the **meningeal venous sinuses** which accompany them, and the intra-cranial part of the **internal carotid artery**

The **anterior fossa** of the skull is limited behind by the sharp posterior margins of the lesser wings of the sphenoid bone In the middle line in the front part of it there is the projecting crista galli which partially divides the fossa into lateral halves attached to the crista is the falx cerebri On each side of the crista there is a depressed part of the fossa in which the **olfactory bulb** is lodged its floor is formed by the cribriform plate of the ethmoid bone whose under surface is lined by the mucous membrane of the roof of the nasal cavities. It is not usually possible to see the **olfactory nerves**, which as fine filaments pass through the foramina of the cribriform plate and join the under surface of the olfactory bulb Lateral to the cribriform plate the floor of the anterior fossa is formed on each side by the thin orbital plate of the frontal bone which also forms the roof of the orbit it bulges upwards and its surface usually presents several prominent sharp ridges which fit into the fissures on the opposed surface of the cerebral hemisphere. The posterior border of the lesser wing of the sphenoid bone terminates medially in

the anterior clinoid process. Running along it there is the small **spheno-parietal venous sinus** which is to be opened; it terminates in the anterior end of the cavernous sinus. The anterior meningeal arteries and some small nerves and vessels which have part of their course in the fossa will be described later.

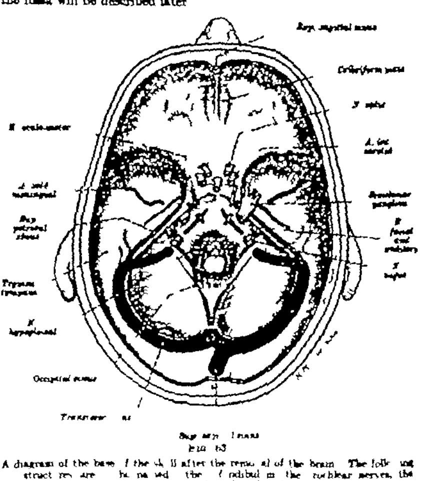


FIG. 63

A diagram of the base of the skull after the removal of the brain. The following structures are to be noticed: the [illegible] trochlear nerves, the great superficial petrosal nerve (on the right side), the inferior petrosal sinuses, the abducent nerves, the glosso-pharyngeal nerves, the spinal part of the accessory nerve and the vertebral artery.

The **olfactory nerves** arise from the olfactory cells in the olfactory mucous membrane on the upper part of the nasal [illegible]. The fibres of the nerves, which are non-medullated, become grouped [illegible] into bundles, and these pass upwards through the foramina of the cribriform plate of the ethmoid bone in medial and lateral groups and end in the inferior surface of the olfactory bulb in which they terminate. Each bundle is surrounded by a sheath of dura and arachnoid mater and there is an [illegible] of the

sub-arachnoid space along it; it is believed that the sheaths may become the pathways of the spread of infection from the nasal cavity to the brain.

The **middle fossa** of the skull comprises (1) a small square median part bounded by *lines joining the four clinoid processes of the sphenoid* bone the posterior processes being the pointed prominences at the ends of the upper edge of the dorsum sellæ and (2) two large **lateral parts**, each of which is bounded in front by the thin curved overhanging posterior border of the small wing of the sphenoid and behind by the superior margin of the petrous part of the temporal bone. The fossa *as a whole is greatly weakened by the foramina and deficiencies* in its floor and it is therefore a common site of fracture.

In the **median part** of the fossa, on each side and just medial to the anterior clinoid process, the **optic nerve** will be seen issuing from the optic foramen. It was cut in its course backwards to the base of the brain. On the lateral side of the nerve there is the cut end of the **internal carotid artery** (Fig 63) and arising from the artery there is to be secured its branch the **ophthalmic artery** which runs forwards below the optic nerve into the orbit. In the middle line behind and between the two internal carotid arteries the **infundibulum** will be seen passing through a small opening in the dura mater into the sella turcica the aperture is in a fold of the cerebral layer of the dura mater the **diaphragma sellæ**, which roofs the sella turcica and covers the **pituitary gland**. The two **cavernous sinuses** lie at the sides of the sella turcica they are short wide channels and typically placed between the two layers of the dura mater (Fig 64)

The free and attached margins of the tentorium cerebelli are to be followed forwards from the apex of the petrous temporal bone to their terminal attachments they form ridges on the surface of the cavernous sinus. The lateral attached margin reaches the posterior clinoid process the central free margin crosses it and extends forwards to the apex of the anterior clinoid process The **oculo-motor nerve** enters the dura mater in the interval between the two attachments, and at the point where the two margins cross one another the delicate **trochlear nerve** will be seen also to enter the dura if the free margin is turned laterally both nerves pass forwards in the lateral wall of the cavernous sinus (Fig 64)

The **diaphragma sellæ** is to be carefully cut away the small transverse **inter-cavernous sinuses** *in its front and back parts being noted.* It varies in its size and the amount of covering it gives the pituitary gland, especially in women sometimes it is almost complete and the opening in it minute and circular and sometimes it is represented only by sickle-shaped front and back margins with a wide opening between them. The **pituitary gland** is to be removed from the sella turcica and examined.

The **pituitary gland** (hypophysis cerebri) is a small ductless gland little more than half a gram in weight, but notwithstanding its small size its

functions are surprisingly many and varied and exceedingly important; it regulates the *growth processes of bones, the functions of the sexual organs*, the activity of visceral muscle, and contributes to the regulation of metabolism, the utilisation of fats, and oxygen consumption, and governs the activity of *most of the other ductless glands*. *It is* reddish-grey oval body slightly flattened from above downwards, 13 mm. from side to side and 10 *mm. from* back to front; and it lies in the sella turcica with its long axis transverse. It is under cover of the diaphragma sellæ the anterior part of which separates it from the optic chiasma *on the base of the brain*; enlargement of the gland soon affects the chiasma. It is separated from the sides from the cavernous sinuses only by their medial walls (Fig. 64); and in the dura mater which lines *the floor of the fossa* and on which it lies there is a loculated venous sinus. The sphenoidal air sinuses are below the floor of the fossa. The dorsum sellæ lies behind it and separates it from the basilar artery and the pons.

If a vertical antero-posterior section is made through the centre of the

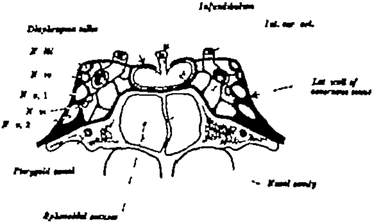


FIG. 64.

Diagram of transverse section through the sella turcica.

gland it will be seen t consist of two parts, a large anterior lobe and a small posterior lobe; the anterior lobe is hollowed out behind to *receive the posterior* lobe. There is a vertical cleft in the back part of the anterior lobe, visible in the glands of young subjects but often obliterated in the old, which divides it into a thick pars anterior in front and *thin pars intermedia in contact* with the posterior lobe. The anterior lobe develops from the ectoderm of the naso-pharynx but normally loses its connexion with it; there are *frequently however remains of it in the mucous membrane of its roof (the* pharyngeal pituitary). The posterior lobe develops as diverticulum from the floor of the third ventricle of the brain the stalk of the diverticulum *persists* as the *infundibulum which* ttaches *the gland* t the brain.

The narrow **spheno-parietal sinus**, which runs along the posterior border of the small wing of the sphenoid bone, is to be opened and followed medially to the **cavernous sinus**, which itself is *now to* be explored by the removal of the dura mater forming its lateral wall

(Fig. 64). The dura is to be divided from the anterior clinoid process to the apex of the petrous part of the temporal bone, the incision passing just lateral to the openings into which the oculo-motor and trochlear nerves pass. The division of the dura is to be continued a little way backwards along the superior border of the petrous part of the temporal bone, the **superior petrosal sinus** which lies there being opened. The flap of membrane thus defined is to be reflected laterally. It forms the lateral wall of the cavernous sinus, and in it, or as it will appear in the dissection immediately underlying it, are the **oculo-motor** and **trochlear nerves** which are to be preserved. Over the apex of the petrous bone the dura mater covers the **semilunar (Gasserian) ganglion of the trigeminal nerve** which is to be exposed by its removal. The ganglion then appears to lie between the two layers of the dura in a space which is named the **cavum trigeminale** (Meckel's cave). The **sensory root** of the trigeminal nerve passes backwards from the ganglion under the superior petrosal sinus and over the margin of the petrous bone into the posterior fossa of the skull, while from its antero-lateral border the three **divisions** of the nerve pass forwards. The **ophthalmic** (first) **division** passes into the lateral wall of the cavernous sinus, the **maxillary** (second) **division** runs in the floor of the sinus, to the foramen rotundum, and the **mandibular** (third) **division** proceeds laterally and downwards to the foramen ovale; the three divisions are to be defined.

The **cavernous sinus** is a short channel (2 cm. long) of irregular quadrilateral form which lies on the side of the body of the sphenoid bone; its position places it in close relation to the pituitary gland and the sphenoidal air sinus, and the semilunar ganglion lies immediately lateral to its posterior end. It is formed by the separation of, and lies between, the two layers of the dura mater (Fig. 64). It commences in front at the medial end of the superior orbital (sphenoidal) fissure and receives there the ophthalmic veins from the orbit and the spheno-parietal sinus; and it terminates behind at the apex of the petrous temporal bone by opening into the superior and inferior petrosal sinuses. The sinuses of the two sides communicate with one another through the small anterior and posterior intercavernous sinuses in the diaphragma sellæ and the sinus in the floor of the sella turcica. Each sinus is connected to the pterygoid and pharyngeal plexuses of veins by emissary veins which leave the skull through the foramen ovale, the foramen lacerum and the carotid canal; the veins in the carotid canal form a plexus round the internal carotid artery and some of them end in the internal jugular vein. It is also to be remembered that since the superior ophthalmic vein communicates with the commencement of the angular vein, the cavernous sinus is connected to the superficial veins of the face. The tributaries of the sinus, in addition to the ophthalmic veins and the spheno-parietal sinus, are the superficial cerebral veins from the lower part of the lateral surface and the inferior surface of the cerebral hemisphere; and into the lateral lacunæ which lie beside it open some meningeal sinuses.

The cavernous sinus derives its name from the fact that traversing it there are numerous interlacing trabeculæ which break up its lumen and make it not unlike the cavernous tissue of the penis. It is also

traversed in their passage forwards by the internal carotid artery which is surrounded by the internal carotid sympathetic plexus, and the abducent nerve. This nerve pierces the cerebral layer of the dura mater in the posterior fossa of the skull over the lower and lateral part of the dorsum sellæ and passes forwards in the sinus it is below the artery behind but on its lateral side in front. The artery and the nerve are separated from the blood stream by a covering of the endothelial lining of the sinus. In the lateral wall of the sinus there have already been defined the oculo-motor trochlear and ophthalmic nerves in that order from above downwards they and the abducent nerve pass forwards to the superior orbital fissure through which they enter the orbit. In the dissection of the orbit they will be studied more fully The maxillary nerve runs its intracranial course in the lateral part of the floor of the sinus (Fig. 61)

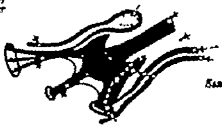


FIG. 65.
A diagram of the structure of the cavum trigeminale

The semilunar (Gasserian) ganglion of the trigeminal nerve lies in a slight depression near the apex of the petrous part of the temporal bone and on the cartilage that fills the foramen lacerum. It is crescentic in shape, nearly 2 cm wide at its broadest part, and appears to be formed of a dense interlacement of fibres. The concavity of the ganglion is directed postero-medially and from it the sensory root of the nerve, flat, grey and striated, passes backwards towards the pons of the brain from the convexity of the ganglion the three divisions of the nerve arise. They are (1) the ophthalmic, the smallest, division, composed entirely of sensory fibres; it passes forwards in the lateral wall of the cavernous sinus and through the superior orbital fissure into the orbit (2) the maxillary division, also entirely sensory it runs forwards for a short distance in the lateral part of the floor of the cavernous sinus and enters the foramen rotundum and (3) the mandibular the largest, division which almost immediately leaves the cranial cavity through the foramen ovale. The fibres of the supero medial part (about one-sixth) of the sensory root belong to the ophthalmic nerve, and the fibres of the larger infero-lateral part to the maxillary and mandibular nerves. The mandibular nerve contains motor as well as sensory fibres they are distributed to the muscles of mastication. They form the motor root of the nerve. It also is attached to

the pons, and from it runs forwards at first on the medial side of the sensory root and then on the deep surface of the semilunar ganglion, to which of course it is not attached; it is to be displayed a a firm round white bundle and followed to the foramen ovale where it joins the mandibular nerve

The roots of the nerve carry on them from the brain covering heaths of the pia and arachnoid mater and when they reach the cerebral layer of the dura mater they evaginate it as it were before them as an outer sheath (Fig 65). The sheaths of the roots are carried over the ganglion which is contained, therefore in a sac of the cerebral layer of the dura mater and the sac itself lies between the periosteal and cerebral layers. The ganglion is thus covered by two laminæ of the cerebral layer of the dura, and rests on two laminæ one of which is cerebral and one periosteal; the upper laminæ are separable but the lower laminæ re fused together Th cavity in which the trigeminal ganglion lies l known as th cavum trigeminale (cave of Meckel).

The part of the **internal carotid artery** which lies in the cavernous sinus is to be cleaned and examined. The artery was followed in the dissection of the neck to the under surface of the petrous part of the temporal bone. There it enters the carotid canal and in it traverses the bone passing at first vertically upwards and then horizontally forwards and medially as is to be seen by examining the canal on the dry skull. It emerges from the canal at the apex of the petrous bone and continuing its course crosses the upper part of the foramen lacerum. It then turns upwards and having pierced the outer layer of the dura mater it bends again and passes horizontally forwards on the side of the body of the sphenoid bone in the cavernous sinus. At the root of the small wing of the sphenoid bone it turns abruptly upwards and pierces the inner layer of the dura mater on the medial side of the anterior clinoid process and close to the optic foramen (Fig 61) It was sectioned there when the brain, to which it is distributed was removed. Throughout its petrosal and cavernous course it is surrounded by a **plexus of sympathetic fibres** which however can hardly be dissected. The plexus is derived from the superior cervical ganglion it gives branches to the third fourth and sixth nerves and the ophthalmic division of the fifth nerve, supplies the pituitary gland, and gives off the deep petrosal nerve While in the cavernous sinus the artery gives small branches to the pituitary gland the semilunar ganglion, and the dura mater of the anterior fossa and close to the optic nerve the **ophthalmic artery** a branch of some size arises from it it runs forwards below the optic nerve into the orbit

The **middle meningeal artery** is to be defined as it enters the skull through the foramen spinosum by cutting through the dura mater that covers it and it is to be traced laterally and forwards across the floor of the middle fossa to the lateral wall of the skull. It reaches the lateral wall about half an inch above the level of the zygomatic arch and there at a varying point it divides into an anterior and a posterior branch The **anterior branch** ascends on the great wing of the sphenoid to the anterior inferior angle of the parietal bone grooving both bones deeply and sometimes on the parietal angle actually being contained in a

canal in the bone It is here, as it crosses the deep surface of the pterion, one and a half inches above the anterior part of the zygomatic arch, that the artery is most easily reached from the surface (Fig 79). It then runs upwards and backwards on the anterior part of the parietal bone, not far behind the coronal suture, its terminal part reaching the middle line In this part of its course it lies over the anterior edge of the motor area of the brain, and hæmorrhages from it will cause pressure on the area. The **posterior branch** passes upwards and backwards on the squamous part of the temporal bone and then over the back part of the parietal bone towards the lambda of the skull. It lies about three-quarters of an inch above the zygomatic arch, and here it is parallel to and practically over the posterior ramus of the lateral fissure of the brain. Both branches send off numerous branches which spread out widely and with the accompanying venous channels occupy grooves on the inner surface of the cranial vault.

The **meningeal arteries** are the nutrient arteries of the bones of the skull (p. 174) and of both layers of the cranial dura mater They lie in the substance of the outer layer of the dura, which is the internal periosteum of the bones, and they and their accompanying sinuses occupy grooves in the bones. They are liable therefore to be implicated in fractures of the bones; the bleeding from them will be extra-dural in position. They anastomose freely with one another and with the vessels of the opposite side. They are derived from a number of sources, but the only vessel of conspicuous size is the middle meningeal artery a branch of the internal maxillary artery and it has been described above; it supplies special branches t the middle ear the semilunar ganglion, and the orbit. The other meningeal arteries are small twigs and not easily secured in an ordinary dissection. Th small meningeal artery may be secured in a well-injected subject, but it is inconstant. It arises from the middle meningeal or directly from the internal maxillary artery and enters the skull through the foramen ovale by the side of the mandibular nerve; it is distributed in the middle fossa in the neighbourhood of the semilunar ganglion. In the anterior fossa there are small anterior meningeal arteries derived from the anterior ethmoidal, middle meningeal, and internal carotid arteries. The posterior meningeal arteries are twigs from the ascending pharyngeal artery which enter through the jugular foramen and the foramen lacerum, from the occipital artery which enter through the jugular and mastoid foramina, and from the vertebral rtery which enter through the foramen magnum

The meningeal arteries are accompanied by the **meningeal sinuses**, but those that accompany the branches of the middle meningeal artery are the only vessels that will be seen. They are larger than the arteries and lie external to them in the substance of the outer layer of the dura mater; and with them they occupy the grooves in the cranial bones. They resemble the sinuses of the dura mater and not veins, in their structure, and they communicate with them and their lateral lacunæ, especially those of the superior sagittal sinus. The sinus that accompanies the posterior branch of the artery usually passes through the foramen spinosum and as a vein ends in the pterygoid plexus, and the sinus that accompanies the anterior branch may end in the spheno-parietal sinus or pass through the foramen ovale and also end in the pterygoid plexus.

The **eminentia arcuata** on the anterior (upper) surface of the petrous bone should now be recognised. The dura mater lateral to it is to be removed and the area of the temporal bone thus exposed carefully examined It is the **tegmen tympani**, the roof of the tympanic cavity and tympanic antrum and in many subjects is so thin as to be translucent. The **great superficial petrosal nerve** is then to be sought just medial to the anterior end of the eminentia arcuata it appears through the **hiatus canalis facialis**, an opening which leads into the canal for the facial nerve and runs forwards and medially beneath the cavum trigeminale of the semilunar ganglion.

The **great superficial petrosal nerve** can be readily exposed, with a small twig of the middle meningeal artery in a groove on the surface of the petrous bone which extends from the hiatus canalis facialis to the lacerate foramen. It is a branch of the facial nerve arising from it in the facial canal, and having emerged from the bone passes forwards and medially under the dura mater below the semilunar ganglion and enters the cartilage of the foramen lacerum on the lateral side of th internal carotid artery It is joined there by the **deep petrosal nerve**, a sympathetic nerve from the internal carotid plexus, and the trunk so formed, the **pterygoid nerve**, passes through the pterygoid canal at the base of the pterygoid process (Fig 64) and joins the spheno-palatine (Meckel') ganglion which is suspended from the maxillary nerve in the pterygo-palatine fossa.

The **small superficial petrosal nerve** is also to be sought. It appears through an opening immediately lateral to the hiatus canalis facialis and runs across the surface of the petrous bone to the interval between it nd the great wing of the sphenoid through which (or through the foramen ovale or a small unnamed foramen beside it) it leaves the skull to reach the otic ganglion (p. 145) It arises from the tympanic plexus in the tympanic cavity and contains motor fibres of th glosso-pharyngeal nerve and sensory fibres of the facial nerve

The **posterior fossa** of the skull is bounded in front by the dorsum sellae and the superior borders of the petrous bones, and at the sides and behind by the lines of attachment of the tentorium cerebelli. It contains the foramen magnum in which lies the upper end of the **spinal cord**, sectioned in the removal of the brain the cord is attached on each side to the margin of the foramen by the highest digitation of the **ligamentum denticulatum**. The **vertebral artery** ascending into the cranial cavity through the foramen magnum, lies in front of the ligament, and in front of it there is the **anterior root of the first cervical nerve**. At a higher level the **hypoglossal nerve** pierces the dura mater it is in two parts and they pass into the anterior condylar foramen behind the vertebral artery (Fig 63) The **spinal root of the accessory nerve** is then to be identified it enters the skull through the foramen magnum behind the ligamentum denticulatum and turns laterally to join the **medullary root** of the nerve. The accessory nerve and the **vagus nerve** then pass through the dura mater together opposite the jugular foramen, and immediately above them the small **glosso-pharyngeal nerve** pierces the dura the three nerves make their exit from the skull through the

jugular foramen, the vagus and accessory nerves being in a common sheath of dura mater The **auditory and facial nerves** pass together into the internal auditory meatus accompanied by a small artery the internal auditory branch of the basilar artery the large motor part of the facial nerve lies highest, the auditory nerve lowest, and the small sensory part (pars intermedia) of the facial is between them. The **trigeminal nerve** has already been described to pass into an opening in the dura close to the margin of the petrous temporal bone, and the **abducent nerve** to pierce the dura over the base of the dorsum sellæ

The Venous Sinuses of the Posterior Fossa.—In the back part of the lower free edge of the falx cerebri there is a small channel the **inferior sagittal sinus**, which runs backwards and terminates in the **straight sinus.** The straight sinus is situated along the line of attachment [illegible] f the falx cerebri to the tentorium cerebelli [illegible] it ends behind at the internal occipital protuberance It is to be opened along its whole length and then the falx cerebri [illegible] to be cut away from its attachment to the tentorium and the occipital bone As this is done the lower part of the **superior sagittal sinus** will be cut across, and the dissector is to demonstrate that over the internal occipital protuberance it turns to the right (in the majority of subjects) and becomes continuous with the right **transverse sinus** whi[illegible]h runs horizontally in the attached borde[illegible] of the right half of the tent[illegible]rium The straight sinus turns to the left and becomes continuou[illegible] with the left lateral sinus (Fig. 63). Th[illegible] arrangement is reversed in a few subjects. As a general rule the two transverse sinuses communicat[illegible] with one anoth[illegible] over the occipital protuberance and occasionally the superior sagittal sinus, the two tran[illegible]erse sinuses and the [illegible]traight sinu[illegible] unite there in a common dilatati[illegible]n the **confluence of the sinuses** (torcular Herophili). In the att[illegible]hed margin of the falx cerebelli there is the small **occipital sinus** it commences ne[illegible] the f[illegible]ramen magnum in two branches which may communi[illegible]ate with the sigmoid part [illegible]f the transv[illegible]rse sinuses, and t[illegible]rminates above in (usually) th[illegible] left tran[illegible]erse [illegible]nu[illegible]

The **transverse sinus** is t[illegible] be opened [illegible] n [illegible] h side by [illegible]utting through the [illegible]ttached bord[illegible]r [illegible]f the t[illegible]nt[illegible]rium [illegible]rebell[illegible] It lies in the tentorium as far a[illegible] the l[illegible]t[illegible]al [illegible]nd of the [illegible]uperi[illegible]r [illegible] rder [illegible]f the petrous bone but there it li[illegible]s d[illegible]wn [illegible]rd[illegible] [illegible]ut of it ont[illegible] the floor [illegible]f th[illegible] posterior fossa the furthe[illegible] part [illegible]f the sinu[illegible] [illegible] named [illegible]n [illegible] [illegible]f [illegible]t[illegible] curved course the **sigmoid part** [illegible]f the t[illegible]ans[illegible]rse sinu[illegible] The **superior petrosal sinus** which runs along the [illegible]upper [illegible] margin of the petr[illegible]u[illegible] bone from the post[illegible]rior end [illegible]f the [illegible] [illegible]ern[illegible]s sinu[illegible] [illegible]t[illegible] be [illegible]pened [illegible]nd it[illegible] jun[illegible]tion behind with the t[illegible]n[illegible]erse sinu[illegible] est[illegible]bl[illegible]shed Th[illegible] t[illegible]nt[illegible]rium cerebelli can then be cut away The [illegible] [illegible]al part [illegible]f the tran[illegible]erse sinu[illegible] is now t[illegible] be freely [illegible]pened t[illegible] [illegible]d[illegible] [illegible] [illegible]t[illegible] [illegible] [illegible]t[illegible] [illegible]urved [illegible]rse across the floor [illegible]f the posterior f[illegible]ssa t[illegible] the back part [illegible]f th[illegible] jugul[illegible]r f[illegible]amen [illegible]t pa[illegible]ses int[illegible] the foramen to be[illegible]ome [illegible]t[illegible] [illegible]nuou[illegible] [illegible]ith the bulb [illegible]f the int[illegible]rnal jugular vein.

The **transverse sinuses** [illegible] 63 [illegible] [illegible] large [illegible] though [illegible] [illegible]ently the[illegible] are unequal the right [illegible] [illegible] is usuall[illegible] the larger They begin at the internal

occipital protuberance one sinus, generally th right, being the continuation of the superior sagittal sinus and the other of the straight sinus. Each sinus runs horizontally forward on the occipit l bone t the posterior inferior angle of the parietal bone in th attached margin of the tentori m cerebelli the course is slightly arched and a little upward so that the highest part of th sinus is on the parietal bone At the base of the petrous bone or just behind it, the sinus turns sharply downward into it sigmoid part. This part runs down ards medially and forwards on the lateral wall of tl posterior fossa towards the post rior part of the jugular foramen resting on, and grooving deeply especially at first, the inner surface of the petro-mastoid part of the temporal bone Its terminal part runs more directly forwards and resting on the jugular process of the occipital bone enters th back of the jugular foramen by a sudden downward bend over a harp ridge of bone; there it opens either into the summit of the j gular bulb or on it anterior wall below the summit The lateral sinuses carry into the internal jugular veins the main venous streams of the cranial cavity; th hief exception are the inferior petrosal sinuses

The tributaries of the transverse sinus, in addition to the superior petrosal sinus and the sinuses which communicat with it at the confluens sinuum, are the posterior inferior cerebral veins, the inferior cerebella veins, and some small veins which issue from the internal auditory meatus. The mastoid emissary vein opens into the posterior w ll of the upper part of its sigmoid part, the opening often being of large size nd near it terminal part there is the opening of the posterior condylar emissary vein.

The horizontal part of th sinus roughly corresponds in position to the superior curved line on the terior of the occipital bone; that is, it runs along a line half an inch wide rched a little upwards, from th external occipital protuberance t the asterion The asterion is at the postero-inferior angle of the parietal bone and on it the top f the bend from the horizontal t the sigmoid part of the sinu is at a point one inch abov and one and half inches behind the centre of the external auditory meatus (Fig 79). The descending part of the sigmoid sinus runs downwards and forwards from the bend as far as the lower edge f the meatus, it course being towards the tip of the mastoid process nd alw ys f rther way from the surf ce of th head The exact position of it anterior w ll, however varies considerably; it is usually farther forwards on the right side than the left that is, nearer the uricle but it is seldom in front of the line along which th skin is reflected from the mastoid process onto the back of the auricle The importance of these facts is that the vertical part of the sinus is related to the tympanic antrum and the mastoid air cells, part which will be seen in the dissection f th ear

The **inferior petrosal sinus** is now to be opened (Fig 63) It begins at the posterior end of the cavernous sinus, which is drained mainly by it, and runs backwards in the groove between the petrous part of the temporal bone and the basilar part of the occipital bone to the anterior part of the jugular foramen. It enters the foramen and passes through it as a vein which joins the upper end of the internal jugular vein just below its bulb or open into the bulb itself. It receives some auditory veins and veins from the medulla the pons, and the under surface of the cerebellum. The sinuses of the two sides are connected across the basilar part of the occipital bone by a plexus of small channels, sometimes called the **basilar sinus**.

The venous sinuses are connected to the veins on the exterior of the skull by the **emissary veins** (p. 50). Some of these veins are more constant than others, and it is of clinical importance to know their position, for inflammatory processes may be conducted along them from the exterior to the interior of the skull, and, further, blood may be abstracted from the sinuses through them. The important emissary veins are: (1) A **mastoid vein** which runs through the mastoid foramen and connects the sigmoid part of the transverse sinus with the posterior auricular veins. (2) A **parietal vein** passes through the parietal foramen and connects the superior sagittal sinus with the veins of the scalp. (3) A vein passes through the foramen cæcum and connects the superior sagittal sinus with the veins of the nose; nasal bleeding, therefore, especially in children, may beneficially drain the cerebral circulation. (4) A **condylar vein** passes through the posterior condylar foramen and connects the end of the sigmoid sinus with the veins of the sub-occipital region. (5) Emissary veins connect the cavernous sinus with the pterygoid plexus through the foramen ovale, and with the pharyngeal plexus through the carotid canal and the foramen lacerum; and it has already been stated that the superior ophthalmic vein connects the cavernous sinus with the angular vein of the face.

DISSECTION OF THE ORBIT

The orbit is to be opened by the removal of its roof and its contents dissected from above. The contents are (1) the **eyeball and the optic nerve** which proceeds from it; (2) the **ocular muscles** which are attached to the eyeball and maintain it in place and effect its movements; (3) a muscle of the upper eyelid, the **levator palpebræ superioris**; (4) the **lacrimal gland**; and (5) the **vessels and nerves** of the eyeball, the muscles and the gland. These structures are embedded in a **mass of loose orbital fat** which fills the intervals between them and between them and the walls of the orbit; the eyeball, however, is separated from the fat by a sheath of fascia, the **fascia bulbi**, which envelops it (Fig. 68).

Th[illegible] soft part[illegible] of th[illegible] head are t[illegible] be reflected downw[illegible]rds from the l[illegible]n[illegible] f[illegible] the upp[illegible] margin of th[illegible] [illegible]bit the periosteum will be seen t[illegible] be [illegible] and it [illegible] the [illegible]bit. Vertical saw-cuts are then t[illegible] be made through the f[illegible] f[illegible] the [illegible] of the orbit at the med[illegible] f th[illegible] [illegible]bit [illegible] horizontal saw-cut [illegible] between them ju[illegible] th[illegible] marg[illegible]n f the orbit. The pie[illegible] f th[illegible] f[illegible] has been d[illegible]fined by the [illegible] is t[illegible] be kn[illegible]ked [illegible] th[illegible] [illegible] of the supra[illegible] left. Th[illegible] f th[illegible] [illegible] way but [illegible] with th[illegible] th[illegible] periost[illegible]um under the bone [illegible] be left [illegible]. In some subject the front[illegible] [illegible] large [illegible] [illegible] will require t[illegible] be [illegible] and there is only [illegible]. Th[illegible] t[illegible] be [illegible] until th[illegible] full[illegible] that th[illegible] nerves which [illegible] the orbit through [illegible] th[illegible] followed [illegible] f bone [illegible] left [illegible] th[illegible] men

The periosteum which clothes the under surface of the roof of the orbit is but loosely attached to it and remains in position when it is removed. It is the upper part of the thick periosteal layer the peri

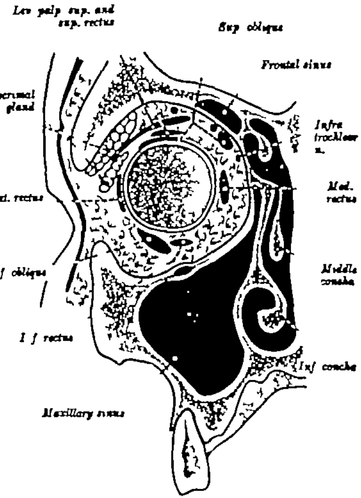


FIG 66.

A coronal section through the orbit It shows the general relations f the orbit and the positio of its contents. The supra-orbital and supra-trochlear nerves are not named th infra-o bital nerve, the continuatio of the maxillary nerve, is in the infra-orbital canal in the floor of the orbit.

orbita, which lines the walls of the orbit and forms a funnel-shaped sheath for its contents. It is continuous behind through the superior orbital fissure and the optic foramen with the periosteal layer of the dura mater and in front it is continuous round the margins of the orbit with the periosteum on the surface of the skull. It is to be divided

to the eyeball (see Vol. I., p 96) Entering the deep surface of the posterior part of the superior rectus there will be seen the **superior division of the oculo-motor nerve** which supplies it and the levator palpebræ superioris. The **optic nerve** is then to be brought into view by carefully removing the fat which covers it. It enters the orbit through the optic foramen carrying with it a loose sheath of dura mater and delicate coverings of the arachnoid and pia mater It inclines laterally and slightly downwards as it passes forwards within the cone of the rectus muscles to the back of the eyeball, which it pierces a little (3 mm) on the medial side of its centre point it is long enough not to impede the movements of the eyeball. As the nerve is being exposed, there are to be secured as they cross its posterior part the **naso-ciliary nerve** (Fig 67) the **ophthalmic artery** (Fig 69) and the **superior ophthalmic vein**. The naso-ciliary nerve is to be cleaned in a forward direction. It passes along the medial wall of the orbit below the superior oblique muscle and divides into two terminal branches, the **infra-trochlear** and **anterior ethmoidal nerves** both nerves are easily secured and isolated. As it crosses the optic nerve the naso-ciliary nerve gives off two or three delicate twigs, the **long ciliary nerves** they run along the optic nerve to the eyeball within which they are distributed These nerves, however may not be found, but the **short ciliary nerves** which accompany them, and are much more numerous are readily discovered. One of them is to be picked up and carefully followed backwards it will lead the dissector to the **ciliary ganglion**, a minute parasympathetic ganglion, which lies on the lateral side of the back part of the optic nerve (Fig 67) The ganglion is to be isolated and, with the exercise of a little care, its connexions with the naso-ciliary nerve and the inferior division of the oculo-motor nerve are to be demonstrated.

The **naso-ciliary nerve** arises from the ophthalmic nerve in the anterior part of the cavernous sinus (Fig 67). It enters the orbit through the medial part of the superior orbital fissure passing between the origin of the lateral rectus muscle and the optic nerv (Fig 70). Running forwards within the con of the rectus muscles, it inclines medially across the optic nerve and reaches the medial wall of the orbit between the superior oblique muscle above and the medial rectus muscle below It divides there into its two terminal branches, the anterior ethmoidal and infra-trochlear nerves. It gives off in its course (1) branch to the **ciliary ganglion** which arises on the lateral side of the optic nerve; (2) the two **long ciliary nerves** which arise as it crosses the optic nerve; they pierce the sclera near the medial sid of the optic nerve; and (3) the **posterior ethmoidal nerve** which arises on the medial wall of the orbit and passes through the posterior ethmoidal foramen t supply the mucous membrane of the ethmoidal and sphenoidal air sinuses it is improbable that it will be found.

The **anterior ethmoidal nerve** leaves the orbit by passing through the anterior ethmoidal canal into the cranial cavity which it enters at the lateral border of the cribriform plate of the ethmoid bone It crosses the cribriform plate under the dura mater and runs through a slit at the side of the crista galli into the nasal cavity where it lies in a groove on the deep surface of the nasal

bone. It gives off three internal nasal branches to the mucous membrane of the nose and, continuing forwards, emerges between the lower margin of the nasal bone and the upper lateral cartilage of the nose as the external nasal nerve. This nerve was seen and its distribution described in the dissection of the face (p. 40).

The infra-trochlear nerve runs along the medial wall of the orbit and, after passing under the trochlea of the superior oblique muscle, escapes from the orbit above the medial angle of the eye and supplies the skin of the eyelids

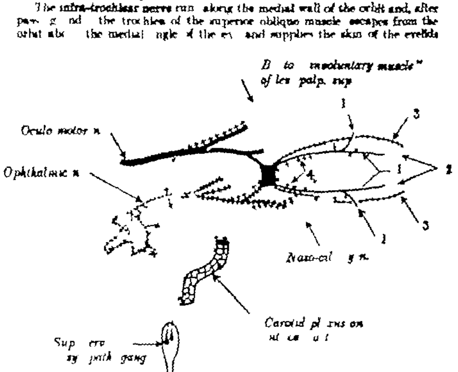


Fig. 68.

A [illegible] of the ciliary ganglion and the distribution of the [illegible] short ciliary nerves (from oculo-motor) to [illegible] sphincter pupillae [illegible] long ciliary nerves (from sympathetic) [illegible] short ciliary nerves (from naso-ciliary) [illegible] ciliary nerves (from sympathetic) [illegible]

[illegible] with the supra-trochlear [illegible] the nerve, the lacrimal [illegible]

The ciliary ganglion [illegible] small flattened [illegible] reddish colour [illegible] back part of the orbit [illegible] commonly [illegible] lateral side [illegible] It [illegible] border three small [illegible] the naso-ciliary nerve, the [illegible] of the oculo-motor nerve to the inferior oblique muscle, and the

sympathetic plexus on the internal carotid artery (Fig 68) Its branches are the short ciliary nerves, six to ten in number They arise from the front of the ganglion in two groups, superior and inferior the lower nerves being the more numerous. They run forwards, one set above and one set below the optic nerve and dividing in their course pierce the eyeball round the entrance of the optic nerve

The short ciliary nerves constitute the chief nerve supply of the eyeball. The sensory fibres in them derived from the naso-ciliary nerve, innervate the outer coat with sensation, giving a very rich supply to the superficial parts of the cornea. The sympathetic fibres in them are the vaso-motor fibres of the blood vessels of the coats of the eyeball, the blood vessels being chiefly those of the middle coat. They are derived from the plexus on the internal carotid artery (p. 183) and, as a rule pass to the ganglion in the naso-ciliary nerve and its branch to it. Their cell station, that is, their origin, is in the superior cervical sympathetic ganglion, and their sympathetic connexion to the spinal cord is through the first and second thoracic nerves. The motor fibres are post-ganglionic parasympathetic fibres whose cell station is in the ciliary ganglion they supply the ciliary muscle and the sphincter pupillæ Their central connexion *is through the branch of the oculo-motor nerve to the ciliary* ganglion, and its fibres alone terminate in the ganglion.

The long ciliary nerves carry sensory and sympathetic fibres. The sensory fibres come from the naso-ciliary nerv ; they chiefly supply the cornea. The sympathetic fibres have the same origin as those of the short ciliary nerves (Fig 68) ; they supply the dilator pupillæ muscle

The sympathetic fibres for the involuntary muscle which is part of the levator palpebræ superioris (p. 81) arise from the carotid plexus and join the third nerve in the cavernous sinus (p. 185) they reach the muscle through the branch of the superior division of the nerv to it (Fig. 68)

The ophthalmic artery is now to be examined, but in an ordinary dissection it is not necessary to spend care to define its numerous small branches. It itself is a branch of the internal carotid artery and accompanies the optic nerve into the orbit through the optic foramen (Fig 69) At first it lies below the lateral part of the nerve, but in the orbit it winds round its lateral side and crosses obliquely over it to reach the medial wall of the orbit. It then passes horizontally forwards above the medial rectus and below the superior oblique muscle and ends near the orbital margin by dividing into two terminal branches, the supra trochlear and dorsal nasal arteries. The branches given off in its course are very numerous they supply (1) the eyeball (2) the ocular muscles (3) the lacrimal gland and (4) parts beyond the orbit particularly the eyelids, the forehead and the nose

1 **Branches to the Eyeball.**—(*a*) The **central artery of the retina**, a small twig is the first branch to be given off It perforates and runs for a short distance within the dural sheath of the optic nerve and bout half an inch behind the eyeball, pierces th under surface of the nerve and runs forw rds in its substance t the retina ; there it spreads out in a network on it inner surface. (*b*) The **ciliary arteries** are very numerous. They supply the middle coat of the eyeball. They are arranged in two groups. The anterior ciliary arteries, six to eight in number spring from the muscular branches and run

orbit through the anterior and posterior ethmoidal foramina. The posterior artery is a small vessel which supplies the mucous membrane of the posterior ethmoidal air sinuses and the upper part of the nose. The anterior artery a larger vessel, accompanies the anterior ethmoidal nerve In its course it gives off branches to the anterior ethmoidal and frontal air sinuses and the small anterior meningeal artery which leaves it while it lies in the cranial cavity (p. 180) and it terminates in branches to the nasal mucous membrane and one which appears on the dorsum of the nose between the nasal bone and the upper lateral nasal cartilage. (c) The supra-trochlear artery accompanies the supra trochlear nerve to the forehead where it has already been dissected (p 43) The dorsal nasal artery leaves the orbit above the medial palpebral ligament and is distributed over the root of the nose.

The **ophthalmic veins** take their origin from the contents of the orbit and, passing from before backwards, unite to form two trunks the superior and inferior ophthalmic veins which open at the medial part of the superior orbital fissure into the anterior end of the cavernous sinus. At the margin of the orbit the beginnings of both veins form connexions with the angular vein of the face and, since no valves occur in the veins or their branches, they form important emissary systems connecting the cavernous sinus and the superficial veins of the face. They are difficult to dissect unless they are specially injected.

The superior ophthalmic vein is the larger It is formed at the medial angle of the orbit by the fusion of two veins which are connected to the supra-orbital and angular veins (p 45) and pass backwards one abov and one below the trochlea of the superior oblique muscle. The vein so formed accompanies the ophthalmic artery and receives tributaries corresponding more or less to its branches. The chief veins from the eyeball, however do not accompany the ciliary arteries they are the venae vorticosae which perforate the sclera about its equator The vein passes through the medial end of the superior orbital fissure generally outside the ring of attachment of the rectus muscles (Fig. 70). The central vein of the retina most frequently passes through the fissure within the ring and pass directly into the cavernous sinus. The inferior ophthalmic vein takes its origin in a plexus of small veins on the antero-medial part of the floor of the orbit; the plexus communicates with the veins of the face. The vein, or a continuation of the plexus representing it, passes backwards below the eyeball and receives some muscular veins and the inferior venae vorticosae it is connected to the pterygoid plexus through the inferior orbital fissure. At the apex of the orbit it either joins the superior vein or passes through the superior orbital fissure outside the rectus ring (Fig 70) and joins the cavernous sinus.

The dissector will have noticed by this time a thin loose membranous tissue round the back part of the eyeball. This is the **fascia bulbi** (capsule of Tenon) and if it is grasped with forceps and a small piece of it cut away a space between it and the eyeball will be opened into It is, therefore, a sort of sac which envelops the eyeball and separates it from the orbital fat.

The fascia bulbi invests the eyeball as far as the margin of the cornea. It fuses behind with the dural sheath of the optic nerve and it ends in front by

close to the opening of the naso-lacrimal canal. It passes laterally and slightly backwards below the inferior rectus and ends in a short tendinous expansion which is inserted into the eyeball under cover of the lateral rectus; the insertion is farther back than the insertion of the superior oblique muscle, being about 18 mm behind the margin of the cornea.

The Action of the Ocular Muscles.—The movements of the eyeballs in man are always closely associated bilateral movements, that is, the two eyeballs are always so moved that images of the bject looked at fall on corresponding points of the two retinæ and single vision with the two eyes results; a *disturbance of the association produces double vision.* The movements themselves as they actually occur are simple and are concerned in maintaining the relationship of the two visual axes. They are of two kinds (1) The movements of both eyes in the same direction, the visual axes being maintained parallel to this class belong the movements of conjugate deviation used in following an object across the field of vision or upwards or downwards; and

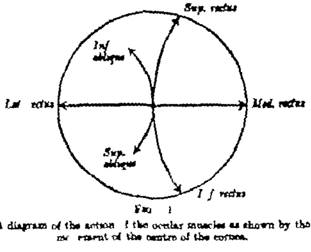


Fig. 1

A diagram of the action f the ocular muscles as shown by the mo ement of the centre of the cornea.

( ) the movements of con ergence of the visual es as t ke place in looking at an object which is coming nearer or is nearer than the object previously looked t the opposit m ement of d ergenc t ke place in looking farther w Other m ement of the eyeballs are arried out only with diffic lty and hen an object is so pla ed as t require them the head is moved until the bject lies between the t

The m ement of the y ball take place round fixed point hich lies a little behind the middle of t antero posterior xis, and theoreticall they are possible round each of the three es hich intersect there M ements round the antero post rior xis b er hich m be the visual axis, are limited, but round the rt l and trans erse es they an occur t as much as 45 t each side nd pward and b ard from the posit n of rest in hich the ey ball is d t d straight f rw rd I the h riz nt l side to side mo ement the medi l nd lat ral rect the ol act m scles the medial movement of the cornea is on ergenc and the lateral mov ment d vergence In pure pa rd nd b rd mo me ts the ol y m scles and the superior and inferior rec t act together for the line of act on of the

recti does not coincide with the vertical axis of the eyeball (Fig 71) their primary action, upwards or downwards, is associated with a medial movement of the cornea and a slight rotation of the eyeball round its antero-posterior axis. The superior rectus thus raises the cornea in an upward and medial direction, and the inferior rectus depresses it downwards and medially The superior oblique acts with the inferior rectus, its insertion being behind the centre of rotation of the eyeball. Its primary action, the depression of the cornea, is accompanied by a secondary action, the movement of the cornea lateralwards; and there is also a rotation of the eyeball in the opposite direction to the rotation produced by the inferior rectus and which therefore neutralises it. The inferior oblique is similarly associated with the superior rectus, its action being to move the cornea upwards and laterally and slightly to rotate the eyeball. Combinations of the muscles of the two sides produce the associated movements of the eyeballs.

The eyeball is to be removed from the orbit and laid aside for comparison with the eyeball of the ox which is now to be dissected. The origin of the ocular muscles round the optic foramen can then be more carefully examined and the entrance of the orbital nerves in two groups more clearly defined. It is also possible now to examine the **maxillary nerve.** Its course is first to be studied on the dried skull. There are to be identified on it the **foramen rotundum** in the great wing of the sphenoid bone and the **infra-orbital groove** and **canal** on the orbital surface of the maxilla the infra-orbital canal opens on the anterior surface of the maxilla at the **infra-orbital foramen.** A probe is then to be passed through the foramen rotundum into the infra-orbital canal it crosses the upper part of the **pterygo-palatine fossa,** a small pyramidal fossa below the apex of the orbit, and enters the orbit through the **inferior orbital fissure.**

The **inferior orbital fissure** lies below and lateral to the optic foramen; it is bounded in front by the upper edge of the posterior surface of the maxilla and behind by the great wing of the sphenoid bone. It is closed in the recent condition by membranous tissue in which there is some involuntary muscle, the muscle of Müller; and it is traversed by the veins which connect the inferior ophthalmic vein t the pterygoid plexus.

The **maxillary** (second) **division of the trigeminal nerve** is composed entirely of sensory fibres. It arises from the semilunar ganglion and runs forwards in the lateral part of the floor of the cavernous sinus to the foramen rotundum (p 184) through which it enters the pterygo-palatine fossa. It crosses the upper part of the fossa, being directed a little laterally as well as forwards, and enters the orbit through the inferior orbital fissure in the orbit it at once passes into the infra orbital groove on its floor It traverses the infra-orbital groove and then the infra-orbital canal as the **infra-orbital nerve** which appears on the face through the infra-orbital foramen there its terminal branches were secured (p 49) and traced to the nose (nasal branches) the lower eyelid (palpebral branches) and the upper lip (labial branches) (Fig 72)

The course of the nerve is to be displayed on one side from before

backwards by opening first the infra-orbital canal and then removing as much of the lateral parts of the maxilla and sphenoid bone as is necessary to expose the pterygo-palatine fossa. This fossa is extremely restricted but in it the **spheno-palatine ganglion**, which is attached to the maxillary nerve and the terminal part of the **maxillary artery** are to be exposed

The maxillary nerve gives off the following branches (Fig. 72) (1) A small **meningeal branch** arises from it within the cranium and is distributed to the dura mater ( ) Two **spheno-palatine branches** arise in the pterygo-palatine fossa and descend to join the spheno-

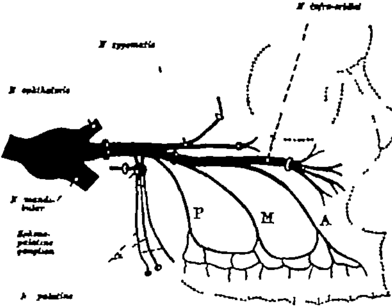


FIG 72.
A diagram of the maxillary nerve and its branches. P.M.A., the posterior middle, and anterior superior dental nerves.

palatine (Meckel's) **ganglion**. (3) The **zygomatic nerve**, a small branch, arises in the pterygo-palatine fossa and enters the orbit by the inferior orbital fissure. It almost immediately divides into two branches, the zygomatico-temporal and zygomatico-facial nerves, which pierce the periosteum and pass forwards and upwards in the lateral wall of the orbit and having traversed minute canals in the zygomatic bone, they appear on the face where they were previously secured and traced to the skin. The zygomatico-temporal nerve is connected to the lacrimal nerve (p. 193) it carries to it the secreto-motor fibres for the lacrimal gland. (4) The **superior dental nerves** are three in number the **posterior** nerve arises in the pterygo-palatine fossa and the **middle** and **anterior**

nerves arise from the infra-orbital nerve in the infra-orbital canal (Fig 12)

The posterior superior dental nerve divides into branches which run downwards on the posterior surface of the maxilla and, having given branches to the mucous membrane of the cheek and the gum, enter the posterior dental canals and supply the molar teeth and the mucous membrane of the maxillary sinus. The middle and anterior nerves arise on the floor of the orbit and may be brought into view by gently raising the infra-orbital nerve. They enter canals which descend on the lateral and anterior surfaces of the maxilla and supply the premolar canine and incisor teeth the anterior nerve also gives off a branch to the mucous membrane of the floor of the nose The three dental nerves communicate with one another and form a looped plexus from which the filaments t the teeth arise; there are condensations of the plexus at the junctions of the middle nerve with the anterior and posterior nerves.

The spheno-palatine (Meckel's) ganglion is a small flattened ganglion, 5 mm in length, which is embedded in soft fat and surrounded by the terminal branches of the maxillary artery in the pterygo-palatine fossa. It is connected to the maxillary nerve below which it lies by two spheno-palatine nerves, but the majority of their fibres pass ver the surface of the ganglion into its nasal and palatine branches. It is also joined, from behind, by the nerve of pterygoid canal which is formed by the union of the great superficial petrosal branch of the facial nerve (p. 187) and the deep petrosal branch of the carotid plexus (p. 187) The ganglion gives off the following branches (1) The orbital branches pass forwards into the orbit through the inferior orbital fissure and supply the muscle of Müller and the orbital periosteum they are exceedingly small. (2) The posterior nasal nerves, in two groups, medial and lateral, pass into the nasal cavity through the spheno-palatine foramen and supply the mucous membrane of the septum and lateral wall of the nose. One of them, the long spheno-palatine nerve, passes obliquely downwards and forwards in a groove on the septum nd through the incisive canal in the hard palat to the roof of the mouth. (3) The palatine nerves are three in number—anterior middle, and posterior (Fig 7). They arise from the lower part of the ganglion, as a rule by a common trunk, which descends in the pterygo-palatine canal; they are composed of sensory fibres, derived from the maxillary nerv and are distributed to the roof of the mouth, the soft palate, and the tonsil. The middle and posterior nerves are small they are distributed t the soft palate and the tonsil. The anterior nerve is much larger It emerges on the palate, through the great palatine foramen and runs forwards in groove on its under surface to the incisive foramen. It supplies the mucous membrane and the glands of the roof of the mouth and communicates with the long spheno-palatine nerve in front. (4) The pharyngeal nerve is a small branch which is distributed to the mucous membrane of the naso-pharynx.

The ganglion thus consists mainly of an interlacement of sensory and sympathetic nerv fibres which are derived from the maxillary nerve and the carotid plexus and are continued into its branches. The only fibres which have their ending in the ganglion are the secreto-motor fibres for the lacrimal gland which are conveyed to it by the great superficial petrosal nerve they are relayed from it to the ygomatico-temporal branch of the infra-orbital nerve

The maxillary artery is described on p 128. Its third or terminal part enters the pterygo-palatine fossa from the infra temporal fossa

and there breaks into a number of small branches they accompany the branches of the maxillary nerve and the spheno-palatine ganglion It is not necessary to spend much time in their dissection.

(1) The posterior superior dental artery descends on the posterior surface of the maxilla and breaks into branches, some of which enter the posterior dental canals and supply the molar and premolar teeth of the upper jaw; other branches supply th gums. (2) The infra-orbital artery accompanies the infra-orbital nerve to the face where its terminal branches were secured. It also gives off the anterior superior dental artery which accompanies the nerve of the same name and supplies the anterior teeth. (3) The descending palatine artery enters the pterygo-palatine canal and passes through the great palatine foramen with the great palatine nerve onto the oral surface of the hard palate. It is known there as the great palatine artery and runs forwards to the incisive foramen through which it passes into the nasal cavity and anastomoses with the vessels of the septum. In the upper part of the pterygo-palatine canal it gives off the small palatine arteries which are distributed to the soft palate, the pillars of the fauces, and the tonsil. (4) The spheno-palatine artery enters the nasal cavity through the spheno-palatine foramen and divides into branches which are distributed on the lateral wall and the septum; one septal branch descends to the incisive foramen and through it anastomoses with the great palatine artery

Dissection of the Eyeball

The general anatomy of the eyeball is to be studied on the eyeball of the ox as it is difficult to obtain the human eyeball in a sufficiently recent condition for dissection. It should be noted, however that the eye of the ox differs from the human eye not only in its larger size, but also in the following particulars (1) the cornea is oval instead of being circular (2) the pupil is elongated into a slit instead of being a round opening (3) in the posterior part of the choroid coat there is an additional layer brilliant green in colour the tapetum which is absent in man and (4) the macula lutea (yellow spot) which is present in the human retina is absent in the ox.

Before the dissection of the eyeball is commenced, the dissector should study Fig 73 an antero-posterior section of the human eyeball, and so obtain a general conception of the parts of which it is formed.

The eyeball consists of a wall of three coats which enclose within them refracting media (Fig 73) The coats are (1) an external fibrous coat, composed of a posterior white opaque part, the **sclera**, and an anterior clear transparent part, the **cornea** (2) an intermediate vascular coat, loaded with dark pigment, the **choroid**; and (3) an internal nervous coat the **retina**, from which the fibres f the optic nerve arise. The choroid coat is subdivided into three parts a major posterior part, the **choroid proper**, which lies deep to the sclera thickened part, the **ciliary body** which lies close to the corneo-scleral junction and an anterior part, the **iris**, which lies behind the cornea and in which there is the central aperture of the **pupil**. The refracting media are (1) the **lens** which lies behind the iris (2) the **aqueous humour**, a watery

fluid, which fills the space between the cornea and the lens the space is partly divided by the iris into the **anterior** and **posterior chambers** of the eyeball which communicate with one another through the pupil and (3) the **vitreous body** a semi fluid jelly like substance which occupies the cavity behind the lens and is enclosed in a delicate membrane the **hyaloid membrane.**

The eyeball of the ox is usually obtained with remnant of the ocular muscles, part of the conjunctiva and the fascia bulbi attached to it, and it is often embedded in a considerable amount of fat. These structures are to be studied noting especially (1) the distribution of the conjunctiva on the eyeball (p 77) and (2) the manner of insertion of the ocular muscles and the relation of the fascia bulbi to them. The

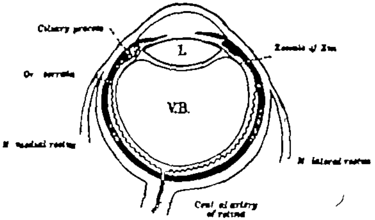


FIG 73.

Diagram f horizontal section of the eyeball. The parts of the three coats of the eyeball are to be named; the hyaloid membrane is internal to the retina.

optic nerve is to be isolated from the surrounding fat and followed to where it perforates the **sclera**, and then the fat and the remnants of the muscles and the redundant conjunctiva are to be removed with scissors so that the surface of the eyeball is cleanly exposed. While this is being done the dissector should secure (1) the **venæ vorticosæ**, four or five in number which perforate the sclera a little posterior to the equator of the eyeball they return the blood from the choroid coat and (2) the **posterior ciliary arteries** and the **ciliary nerves** which pierce the sclera round the entrance of the optic nerve. The eyeball can now be seen to be nearly globular in shape but to consist of two segments of different curvature the smaller anterior corneal segment being more curved than the larger posterior scleral segment.

The surface of the sclera and the cornea should now be examined. The **sclera**, commonly known as the white of the eye, is a dense opaque fibrous tissue, and forms the posterior five-sixths of the outer coat of

the eyeball. It is pierced posteriorly about one-eighth of an inch (in the human eye) on the *medial side of its centre point by the optic nerve.* There the dura mater sheath which envelops the nerve, and which is as easily demonstrated in the human subject as in the ox, blends with the sclera and the nerve fibres pass through a number of small openings in it. The perforated area of the sclera is named the **lamina cribrosa.** A thin layer of the sclera is to be sliced off over the entrance of the optic nerve and the lamina cribrosa examined with a hand lens; the bundles of nerve fibres in the perforations can be seen and in the centre of the nerve the **central artery of the retina** can be distinguished. The substance of the sclera is directly continuous with that of the cornea at the **corneo-scleral junction,** and it is to be noted that as seen from the front the scleral tissue slightly overlaps the corneal tissue; the line of junction, therefore, when seen in section, is oblique (Fig. 74). The **cornea,** clear and transparent in life, forms the anterior sixth of the outer coat of the eyeball. Its curvature is *greater* than that of the sclera. Its anterior surface is covered by a continuation of the conjunctiva, which is reduced at its margin to a thin transparent epithelial layer, the **corneal epithelium**; *part of it is to be scraped away to* demonstrate its thinness.

The sclera is now to be divided into two parts by a circular incision round the equator of the eyeball. A very sharp knife is to be used to make a small incision through that layer by layer until the subjacent black choroid coat is almost reached and becomes visible. One blade of a pair of scissors is then to be introduced beneath the sclera, and by keeping the point of the blade close against its deep surface it is an easy matter, with a little practice, to complete the division of the sclera without injury to the choroid. The space which is opened into is the **perichoroidal space.** The posterior part of the sclera is to be reflected from the choroid, to which it is only very loosely attached across the perichoroidal space by some pigmented trabecular tissue named the **lamina fusca.** At the exit of the optic nerve, however, the two layers are closely united, and the fibres of the nerve must be cut [illegible] the separation. On the half sphere of the sclera which has now been detached it [illegible] noted that the [illegible] is thickest posteriorly [illegible] and becomes thinner as it passes forward [illegible] behind the margin of the [illegible] ball) [illegible] becomes thick [illegible] of [illegible] (Fig. [illegible])

The [illegible] surface of the **choroid** [illegible] The [illegible] the [illegible] part of the [illegible] It lines the deep surface of the [illegible] behind which [illegible] the [illegible] part of the eyeball [illegible] through the sclera. In the [illegible] nerves pass forward [illegible] the nerves will be seen as

delicate white filaments on the surface of the choroid if it is carefully brushed (under water) with a camel hair brush.

The choroid is composed of blood vessels embedded in a loose network of heavily pigmented cellular tissue. The vessels are arranged in two layers, a deep layer of closely meshed capillaries (lamina chorio-capillaris) and a superficial layer of larger vessels of which the venae vorticosae form the chief bulk; these veins may be seen as white lines converging to the main trunks which pierce the sclera, if the pigment is washed out of the choroid. In the eyes of many mammals, but not in man, there is a brightly coloured layer in the outer part of the choroid named the tapetum; in the ox it is brilliant green in colour.

The **ciliary nerves** are branches of the ciliary ganglion (short ciliary nerves) and the naso-ciliary nerve (long ciliary nerves). They pierce the sclera round the entrance of the optic nerve and pass forwards between the sclera and choroid to the region of the ciliary body, where they break into branches which supply the ciliary muscle, the muscles of the iris, and the cornea (p. 197). In the posterior part of the eyeball they lie in grooves on the deep surface of the sclera. The **ciliary arteries** are branches of the ophthalmic artery, and are arranged in three groups according to their distribution. (1) The short posterior ciliary arteries pierce the sclera round the optic nerve and are distributed in the choroid coat. (2) The long posterior ciliary arteries, two in number, perforate the sclera one on each side of the optic nerve and pass forwards between the sclera and the choroid to the ciliary region. There they form an arterial circle at the periphery of the iris which is joined by (3) the anterior ciliary arteries, small twigs which pierce the sclera close to the corneal junction. Branches are given off from this circle to the ciliary body and the iris.

The **retina**, the functional layer of the eyeball, is firmly attached to the deep surface of the choroid, and in such a dissection as the student is making cannot be separated from it; nor can much of the details of its arrangement be demonstrated. The student must supplement his dissection with the examination of museum specimens. The retina consists of two layers, an external **pigmented layer** which adheres to the deep surface of the choroid, and an internal **nervous layer** in which are the visual cells and from which the optic nerve originates. An attempt should be made to strip off the choroid under water and to expose, at least in part, the thin grey opaque membrane which is the nervous layer of the retina. In life it is transparent and purplish red in colour owing to the pigment, the visual purple, in its outer layers, but it becomes opaque at death. In favourable circumstances the branches of the **central artery** and **vein of the retina** will be seen *ramifying* on its inner surface when it is looked at from the front; they appear at the centre of a conspicuous white disc, the **optic disc**, which is the area of exit of the optic nerve from the retina.

The retina lies deep to the choroid and its pigmented layer is adherent to it; and it is moulded on the surface of the vitreous body enclosed in the hyaloid membrane, from which it is perfectly free except at the entrance of the optic nerve. The retina diminishes in thickness as it passes forwards from

the back of the eyeball and appears to end a short distance in front of the equator of the eyeball in a notched margin named the ora serrata; but though its functional visual elements do not extend beyond this line a thin pigmented lamina consisting of two layers of cells which represent the two layers of the retina, is prolonged over the ciliary body and on the back of the iris to the margin of the pupil (Fig 74). These undeveloped non functional parts of the retina are named the pars ciliaris and the pars iridica retinae. The fibres of the optic nerve arise in the innermost layer of the retina proper and pass on its internal surface to the optic disc, which is often named the entrance of the optic nerve. The disc is situated on the posterior part of the retina a little

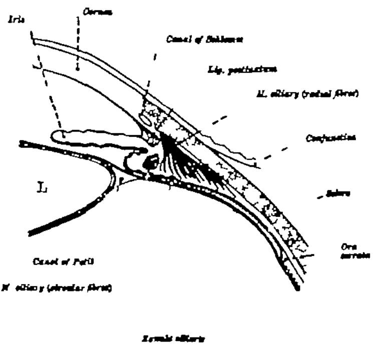


FIG. 74.

A diagram of section of the anterior part of the eyeball. The retina, the choroid, the ciliary body the iris, the cornea, and the lens are to be coloured, and the anterior and posterio chambers f the eyeball are to be shaded.

(3 mm. in the human eye) on the medial side of its centre point, and when seen from the front appears as a conspicuous white oval area (in the human eye 1·7 mm. in vertical diameter and 1·5 mm. in horizontal diameter); in the centre of the disc there is a slight hollow known as the optic cup. At the centre point of the retina, and therefore on the lateral side of the optic disc, there is in the human eye a small oval yellowish spot, the macula lutea, and in its centre a slight depression, the fovea centralis. The central artery of the retina emerges in the middle of the optic disc and immediately divides into upper and lower branches which ramify on the surface of the retina as far as the ora serrata. The retinal veins accompany the branches of the

artery and converging towards the optic disc form two trunks which pass with it into the substance of the optic nerve.

The **vitreous body** enclosed in the **hyaloid membrane**, and carrying with it the **lens** in its **capsule**, is now to be shaken out of the anterior part of the eyeball. It should be allowed to drop into a vessel filled with water well tinted with picro-carmine, and when it is sufficiently stained is to be removed to clear water

In the anterior part of the eyeball the **ciliary body** and the **iris** are to be examined from behind, the specimen being looked at under water

The **ciliary body** is a thickened part of the vascular coat it is covered on its deep surface by the pars ciliaris retinæ which is adherent to it. It is thrown into a series of folds, the **ciliary processes**, about sixty to eighty in number in the human eye they are seen in the specimen to be radially arranged, forming a sort of frill behind the iris and jet black in colour The processes are continuous with the choroid behind. As they extend forwards they become more prominent, and close to the peripheral margin of the iris they terminate in rounded ends The free edges of the processes are attached to a thickened part of the hyaloid membrane known as the **zonula ciliaris** (zonule of Zinn) and the lines of attachment are usually quite distinctly marked on the hyaloid membrane as a circle of radiating lines just beyond the periphery of the lens.

The **ciliary processes** are similar in structure to the choroid. Their inner surfaces are covered by the pars ciliaris retinæ which comprises the outer pigmented layer of the retinæ proper and the epithelial continuation forwards of the nervous layer

The **ciliary muscle** which lies in the ciliary body cannot be defined in an ordinary dissection, but its general position and relations will be xamined later It is composed of involuntary muscle fibres arranged in two groups. (1) The radiating fibres arise from the deep surface of the sclera close to the corneal margin and pass backwards to be inserted int the ciliary processes (Fig. 74). This part of the muscle is the chief agent in effecting the accommodation of the eye; when it contracts it draws the ciliary processes forwards and with them the zonula ciliaris and the suspensory ligament of the lens which is continued from it; the suspensory ligament is thus relaxed and allows the lens to become more convex. (2) The circular fibres lie on the deep surface of the radiating fibres they are over-developed in long-sighted eyes but are ill-developed or ven rudimentary in short-sighted eyes. The ciliary muscle is supplied by the oculo-motor nerve through the ciliary ganglion and the short ciliary nerves.

The cornea is now to be cut through from the front all the way round close to the corneo-scleral junction, so that when it is lifted away the iris can be examined from the front as well as from behind. On the posterior surface of the detached piece of the cornea an elastic layer the **posterior elastic lamina** (of Descemet) is to be looked for it will probably have become wrinkled and can then be torn away in

shreds from the cornea and its elasticity demonstrated. At the peripheral margin of the cornea it becomes broken up and fibrillar. Some of its fibres are reflected across the irido-corneal angle onto the anterior surface of the iris forming the ligamentum pectinatum (Fig 74) between the bundles of its fibres there are recesses which are known as the filtration spaces of the irido-corneal angle (spaces of Fontana).

The cornea is almost circular in outline in the human eyeball and nearly uniform in thickness. It projects forwards in front of the sclera but its curvature varies in different subjects and at different periods of life; it is most curved at birth and from then progressively flattens. It consists of tough transparent avascular fibrous tissue arranged in layers and is covered on its outer surface by the epithelial layer derived from the conjunctiva and on its inner surface by the posterior elastic lamina. It is plentifully supplied with sensory nerves derived from the ophthalmic nerve and reaching it through the ciliary nerves; they form a specially dense plexus under the epithelium. The rim of the cornea sometimes undergoes fatty degeneration in the aged and form a yellowish-whit ring, the arcus senilis.

The iris is a circular contractile diaphragm perforated a little to the nasal side of its centre by the pupil, the size of which is constantly varying during life to control the amount of light admitted to the retina. The circumference of the iris is continuous with the ciliary body and is connected to the cornea by the ligamentum pectinatum. Its posterior surface lies immediately in front of the lens and its pupillary margin rests on it; it is deep black in colour being covered by the pars iridica retinæ. Its anterior surface is faintly striated in a radial direction by the arteries in it. The colour of the iris ranges from dark brown to light blue and is determined by the amount and distribution of the pigment in it; in light eyes the pigment is confined to its posterior surface while in dark eyes it extends through its substance. The iris divides the space between the cornea and the lens into an anterior chamber and a posterior chamber the latter being only a narrow cleft between the iris in front and the front part of the ciliary processes the suspensory ligament of the lens, and the lens behind. The two chambers are filled with the aqueous humour, a watery fluid secreted by the ciliary processes, and communicate with one another through the pupil.

The movements of the iris are produced by the involuntary muscle fibres embedded in the connective tissue stroma which forms its substance. There are two sets of fibres, circular set and radial set. The circular fibres form the sphincter pupillæ band about 1 mm. wide round the margin of the pupil; it is supplied by the oculo-motor nerve through the ciliary ganglion and the short ciliary nerves. The radial fibres form the dilator pupillæ; they are supplied by sympathetic fibres in the long ciliary nerves (Fig 68).

The vitreous body is a transparent jelly like body which occupies the interior of the eyeball behind the lens and supports the retina.

It is enclosed within a delicate transparent membrane named the **hyaloid membrane**, which, however is strong enough to allow it to be handled with considerable freedom.

Running forwards through the vitreous from the entrance of the optic nerve to the posterior surface of the lens there is a minute canal, the **hyaloid canal**, lined by a prolongation of the hyaloid membrane It cannot be seen, however unless the vitreous is stained. In the fœtus a branch of the central artery of the retina passes along the canal to the capsule of the lens.

In the region of the ciliary processes the hyaloid membrane is thickened by an accession of radial fibres. The thickened part is named the **zonula ciliaris** (zonule of Zinn) the ciliary processes are firmly attached to it as is shown by the pigmented markings on it when it is removed from them. As it approaches the margin of the lens the zonule splits into two layers (Fig 74) The posterior layer is very delicate and lining the depression in which the lens is placed, encloses the vitreous in front The anterior stronger layer the **suspensory ligament of the lens**, is attached to the anterior surface of the capsule of the lens a short distance beyond its equator (Fig. 74) and scattered fibres from it are also attached to the region of the equator itself. The ligament of the lens retains the lens in position it is relaxed by the contraction of the radiating fibres of the ciliary muscle.

The point of a very finely drawn glass tube to which an india rubber tube is fixed is to be inserted through the suspensory ligament of the lens and an attempt made to inflate a trabeculated space the **spatia zonularis** (canal of Petit) which surrounds the circumference of the lens It lies behind the suspensory ligament and when inflated presents a sacculated appearance it contains fluid which probably is concerned with the nutrition of the lens.

The **lens** is a clear transparent biconvex body enclosed within a structureless elastic capsule to which the suspensory ligament is firmly attached. The anterior wall of the capsule which is thicker than the posterior wall is to be scratched with the point of a sharp needle a little pressure will then cause the lens to escape through the opening. The capsule of the lens can now be very well examined. The anterior surface of the lens it is to be noted, is not so highly curved as the posterior surface and if it is compressed between the finger and thumb the lens can be shown to consist of a soft cortical part and a central nuclear part which is much firmer The changes in curvature of the lens which take place in accommodation are chiefly of the anterior surface.

The hyaloid membrane which lies behind the lens and bounds the fossa in the front part of the vitreous in which the lens lies is to be punctured with blunt forceps the escaping vitreous will be seen and if a piece of it is rubbed in the fingers its fluid watery nature will be appreciated

A meridional section of the corneo-scleral junction is to be made by cutting the front part of the eyeball with sharp scissors the iris

is to be included in the section The surface of the exposed parts is to be examined with a hand-lens (Fig 74) The substance of the sclera will be seen to be continuous with the substance of the cornea, the line of junction being obliquely backwards and inwards. The **ciliary muscle** will be seen as a greyish semi-transparent band on the outer surface of the ciliary processes. *It arises from a small forward projection of the deep part of the sclera known as the* **scleral spur** and passes backwards into the ciliary processes. In the substance of the sclera close to the corneal junction, and just external to the ligamentum pectinatum and in front of the scleral spur to which the ligamentum pectinatum is in part attached there is a small cleft this is a section of a circular canal, the **sinus venosus sclerae** (canal of Schlemm) It communicates internally with the anterior chamber of the eye through the filtration spaces of the pectinate ligament at the irido-corneal angle and externally with the anterior ciliary veins and it serves to drain the aqueous humour from the anterior chamber and to transmit it into the veins. The irido-corneal angle is thus often named the filtration angle.

DISSECTION OF THE EAR

The organ of hearing can be naturally subdivided into three parts (Fig 75). (1) The **external ear** consists of the auricle and the external auditory meatus. The **auricle** collects the waves of sound which are then conducted along the **meatus** to the **membrana tympani** (the drum of the ear) which closes the inner end of the meatus and separates it from the middle ear (2) The **middle ear** is an irregular air filled space within the temporal bone It comprises a narrow central part, the **tympanic cavity** which lies deep to the tympanic membrane and into which a needle would pass if pushed through the membrane. Stretching across the tympanic cavity from the tympanic membrane to its inner wall there is a chain of three small bones, named the **auditory ossicles** they serve to transmit the vibrations of the membrana tympani across the tympanic cavity to the internal ear A second part of the middle ear named the **tympanic antrum**, lies behind and opens into the back part of the tympanic cavity and a third part, the **pharyngo-tympanic** or **Eustachian tube** opens into it in front it connects the tympanic cavity to the upper part of the pharynx. The middle ear then, comprises the tympanic cavity the tympanic antrum, and the pharyngo-tympanic tube (3) The **internal ear** the essential part of the organ of hearing consists of a complicated system of cavities, the **bony labyrinth**, in the substance of the petrous part of the temporal bone. The bony cavities contain within them fine membrane-walled tubes, the **membranous labyrinth**, of the same general shape as themselves but only partially filling them the membranous labyrinth contains a fluid named endolymph and the space between it and the wall of the bony labyrinth is filled with fluid called perilymph. The bony labyrinth consists of three parts (1) an anterior part coiled spirally

like a snail's shell, the **cochlea**; (2) a posterior part in the form of three **semicircular canals**; and (3) an intermediate oval part, the **vestibule**, into which the cochlea and the *semicircular canals open*. The membranous labyrinth consists of the same three parts, and to them the two divisions of the eighth nerve are distributed. The cochlear division of the nerve is distributed almost entirely to the membranous cochlea, and it therefore is the organ of hearing; the vestibular nerve is distributed to the membranous parts in the vestibule and the semicircular canals, and they constitute the organ of equilibration (p. 11).

The exposure of the parts of the ear cannot be undertaken in great detail in an ordinary dissection, but as they are frequently concerned in disease processes for the cure of which surgical interference is

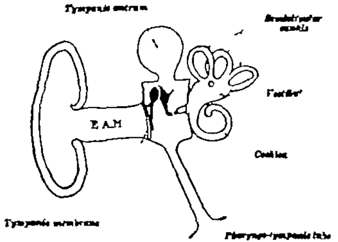


FIG. 75.

A diagram of the auditory apparatus looked at from above. The auditory ossicles are in the tympanic cavity. E.A.M., external auditory meatus.

necessary, a detailed knowledge of their arrangement and relations is necessary. It is important to remember, for example, that the facial nerve passes through the *petrous part of the temporal bone* in close relation to the vestibule, the tympanic cavity and the tympanic antrum. The student's aim should be to acquire by the simplest dissection a general knowledge of the arrangements of the parts, an appreciation of their size, and a clear picture of their important relations; the details can be studied afterwards on permanent specimens and on enlarged models.

The **auricle** has already been examined (p. 54). The tragus of the auricle is to be cut away to expose more fully the orifice of the **external** *auditory meatus* which lies at the bottom of the concha. The anterior wall of the whole length of the meatus is then to be removed, the outer **cartilaginous part** with the knife and the inner **bony part** with small

bone forceps, so that the canal is fully opened and the outer surface of the tympanic membrane is exposed.

The external auditory meatus is about an inch (24 mm.) long from its orifice at the bottom of the concha to the tympanic membrane. Its general direction is horizontally inwards with a slight inclination forwards but there is a gentle sigmoid curve in the horizontal plane and a slight curve in the vertical plane convex upwards; that is, it has a backward bend about its middle part and its floor first rises and then sinks. It can be made almost straight, when it requires to be examined, by pulling the auricle upwards and backwards. The size and shape of the meatus are not uniform throughout. It is narrowest about a quarter of an inch (5 mm.) from the tympanic membrane, this constriction being known as the isthmus, and it is also narrower at the junction of its bony and cartilaginous parts. Its greatest diameter is vertical at the outer end and antero-posterior at the inner end. The wall of the outer part of the meatus is formed by cartilage and the inner

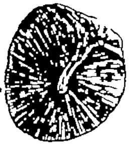


FIG. 78.

The tympanic membrane as seen from the external auditory meatus. The handle of the malleus, the descending process of the incus, and the tympano-malleolar folds are to be named.

part is bone; and it is lined with skin. The cartilage part is about 8 mm. long. The cartilage is continuous with the cartilage of the auricle and at its inner end is attached to the rim of the bony part; it is deficient above and behind, the tube being completed there by tough fibrous tissue. The bony part is about 16 mm. long. Its anterior wall, floor and posterior wall are formed by the tympanic part of the temporal bone and its roof and the upper part of its posterior wall by the squamous part; at its inner end there is a groove in it in which the rim of the tympanic membrane is attached. The skin lining the cartilaginous part is provided with hairs directed to the orifice and is furnished with sebaceous and ceruminous (wax) glands; it is closely attached to the perichondrium of the wall. The skin lining the bony part is thin, is without hairs, and has no glands except in a strip along the roof. It is continued as a very thin layer over the outer surface of the tympanic membrane. The sensory supply of the skin is through the auriculo-temporal nerve and the auricular branch of the vagus nerve.

The meatus is related in front to the temporo-mandibular joint, the parotid gland is moulded on its floor and it lies against the front wall of the mastoid process behind. In the infant the meatus is much shorter and

narrower and the tympanic membrane much nearer the surface of the head for the bony part is at birth but a thin ring; the tympanic membrane which it supports is nearly as large as in the adult. The tympanic ring completes its growth and becomes the tubular canal of the meatus at about the twentieth year; till the sixth year there is a perforation in its floor

The tympanic membrane is a delicate semi transparent oval disc, 0 1 mm in thickness, which separates the external meatus from the tympanic cavity; the floor of the cavity however is ·5 mm. below the lower margin of the membrane. It is not vertically placed but slopes obliquely inwards and forwards; the anterior wall and the floor of the external meatus are thus longer than the posterior wall and the roof. The tympanic membrane is tightly stretched to receive better the sound waves conducted to it, and when looked at from without, as is done in the examination of the living subject, is deeply concave (Fig. 76) The deepest point of the concavity is named the umbo, and corresponds with the lower end of the handle of the malleus, one of the auditory ossicles, which is attached to the deep surface of the membrane and can be seen through it. From the umbo the handle of the malleus passes upwards and slightly forwards almost to the edge of the membrane; it ends at a slight projection caused by the lateral process of the malleus impinging on the deep surface of the membrane Above this process there is a triangular area of the membrane thinner and less tense than the remainder It is the pars flaccida (Shrapnell's membrane), and is limited in front and behind by relatively thickened folds, the anterior and posterior tympano-malleolar folds. The rim of the tympanic membrane, apart from the pars flaccida, is embedded in the circular groove (sulcus tympanicus) at the inner end of the tympanic part of the temporal bone. The membrane consists of fibrous tissue covered externally with thin skin and internally with the mucous membrane of the tympanic cavity

The auricle is to be cut away and all the soft parts including the periosteum, are to be removed from the surface of the mastoid region of the temporal bone The dissector is then to identify exactly first on the dry skull and then on the specimen (1) the **supra-meatal crest** which passes backwards above the auditory meatus and is continued into the lower temporal line (p 51) and (2) the **supra-meatal triangle,** a small depressed area of the post-meatal part of the squamous part of the temporal bone, which lies above the postero-superior quadrant of the bony external meatus (Fig 78) A horizontal saw-cut is then to be made through the lateral wall of the skull at the level of the upper surface of the petrous temporal bone and a vertical cut is to be carried down to meet it behind the region of the mastoid process. The part of the skull wall thus defined is to be knocked away The dissector must now turn to the upper (anterior) surface of the petrous temporal bone in the middle fossa of the skull, and carefully remove the **tegmen tympani** in thin shavings with a small chisel and a mallet the tegmen has already been defined as the area of bone lateral to the eminentia arcuata. By this dissection the **tympanic cavity** will be opened from above and the dissector will have appreciated the thinness of the bone which separates this part of the middle ear from the middle fossa of the skull and he will understand that an intra-cranial extension of

an inflammatory condition of the middle ear is always to be feared. The removal of the tegmen tympani must be carried backwards until the tympanic antrum is also opened, and then in forward and lateral directions until the inner surface of the tympanic membrane can be distinctly seen. The **auditory ossicles** will have presented themselves in the tympanic cavity and as they must be removed before it can be examined they are to be studied while still in position.

The auditory ossicles are three in number and are named the **malleus**, the **incus**, and the **stapes** (Fig. 77) They extend in a chain across the tympanic cavity and transmit the movements of the tympanic membrane to the perilymph of the bony labyrinth of the internal ear The large rounded **head of the malleus**, supported on a short **neck**, is easily recognised. It lies close beneath the tegmen tympani and it should be noted, well above the leve of the tympanic membrane.

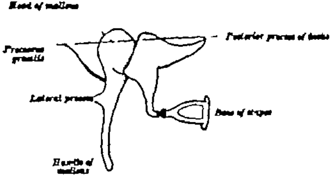


FIG. 77

A diagram of the auditory ossicles articulated together The dotted line is the axis of movement; *it runs from the front to the back wall of the tympanic cavity*

Extending downwards from the neck and attached to the inner surface of the fibrous tissue of the tympanic membrane is the **handle** of the malleus, and at its root is the stunted **lateral process** which abuts against the tympanic membrane immediately below the apical part of the pars flaccida. Passing anteriorly from the neck to be fixed by ligaments in the petro-tympanic (Glaserian) fissure there is a slender spicule of bone the **processus gracilis** it will break when the malleus *is lifted out of the cavity* *The* **incus** *is shaped like a tooth with two* widely divergent fangs. The **body** of the bone articulates with the lower part of the back of the head of the malleus. The shorter of the two processes is directed backwards and its extremity is attached by ligaments to the posterior wall of the tympanic cavity below the opening into the tympanic antrum. The longer process passes downwards and medially nearl parallel with, but behind and medial to, the handle of the malleus nd ts extremity which is bent medially

articulates with the head of the stapes. The **stapes**, so named because it is shaped like a stirrup lies horizontally It articulates by its head part with the long process of the incus. The two crura, the posterior of which is the more curved join the foot plate or **base** this part fits into the foramen vestibuli (or ovale) an opening on the inner wall of the tympanic cavity which leads into the vestibule of the bony labyrinth, and is fixed to its margin by an annular ligament.

The movements of the auditory ossicles normally occur with the movements of the tympanic membrane When the membrane moves inwards it carries with it the handle of the malleus, and the malleus and incus are made to rotate together round an antero-posterior axis formed by the processus gracilis of the malleus and the posterior process of the incus In this movement the descending process of the incus moves medially and the foot plate of the stapes will therefore be pressed into the foramen vestibuli the original movement of the membrana tympani is thus communicated to the perilymph in the bony labyrinth. The movements of the bones are reversed when the tympanic membrane moves outwards but if the movement of the membrane is exaggerated, as may occur when the tympanic cavity is inflated through the pharyngo-tympanic tube the incus does not follow the malleus for the joint between the two bones unlocks the danger of pulling the foot plate of the stapes out of the foramen vestibuli is thus avoided.

There are two small muscles attached to the auditory ossicles one to the malleus, the **tensor tympani**, and one to the stapes the **stapedius** they contract reflexly to damp the vibrations of sounds of high intensity and so protect the internal ear The details of their attachments cannot be studied in an ordinary dissection for both muscles are very small.

The **tensor tympani** arises from the upper part of the cartilage of the pharyngo-tympanic tube and from the adjoining part of the great wing of the sphenoid bone and passes backwards into a bony canal in the temporal bone which leads it to the tympanic cavity The canal lies above the osseous part of the pharyngo-tympanic tube and is separated from it by a thin plat of bone, named th processus cochleariformis (Fig 80). The tendon of the muscle enters the front part of the tympanic cavity and, turning at right angles round the posterior edge of the processus cochleariformis, passes laterally to be inserted into the upper part of the handle of the malleus. The muscle is supplied by the mandibular nerve through a branch from the otic ganglion.

The **stapedius** muscle arises from the wall of a small conical cavity which lies behind the posterior wall of the tympanic cavity and opens into it on a pyramidal eminence. The delicate tendon of the muscle passes into the tympanum through the opening and is inserted into the posterior surface of the neck of the stapes It i supplied by a branch of the facial nerve.

The auditory ossicles are to be picked out of the tympanic cavity and examined, though it will not be possible to obtain the stapes entire The removal of the tegmen tympani is then to be carried forwards until the openings of the **pharyngo-tympanic** tube and the canal for the

eminence named the **pyramid** it is perforated on its summit and transmits the delicate tendon of the stapedius muscle. On the lateral side of the pyramid there is a small foramen through which the chorda tympani nerve a branch of the facial nerve, enters the tympanic cavity The **tympanic antrum** is an air filled cavity in the base of the petrous part of the temporal bone about 12 mm. from front to back 7 mm. from side to side, and 9 mm. in vertical height. It communicates in front with the tympanic cavity and through its floor and posterior wall with the mastoid cells, which vary considerably in number size, and form (Fig 80) The mastoid cells communicate with one another and like the antrum the uppermost of them at least are lined with mucous membrane continuous with that of the tympanic cavity The position of the antrum is to be carefully examined. It lies at a depth on an average, of about half an inch (15 mm.) from the surface, but is variable in this respect in the child it is nearer the surface. Its lateral wall is formed by the post meatal part of the squamous temporal bone and on the surface its position is indicated by the supra meatal triangle (Fig 79) and using the gouge the student is to open the antrum through the triangle. The removal of the bone must be in a direction slightly forwards, parallel with the posterior wall of the bony external meatus. This is the route by which the surgeon enters the antrum in operating for the relief of middle ear disease. The sigmoid part of the transverse sinus lies behind the antrum and at a lower level, but, like the antrum, its depth from the surface is variable.

The tympanic antrum lies above and behind the external auditory meatus and behind the tympanic cavity in the base of the mastoid process and is surrounded by the mastoid cells. It is present at birth, being developed with the tympanic cavity of which it is a part; and it shares in its disease processes. Its roof is formed by the back part of the tegmen tympani which lies just above the level of the supra meatal crest on the exterior of the skull. Its front wall is a plat of bone which separates it from the back of the tympanic cavity and the inner part of the external auditory meatus; in the uppermost part of it is the opening of the aditus which is about 6 mm. in diameter On the medial wall of the aditus is the canal of the facial nerve (see below) and here also, just above and behind the canal, the external semicircular canal is embedded in the bone (Fig 80); the facial canal is opposit the superior and posterior borders of the external meatus 14 to 22 mm. from the surface. The posterior wall of the antrum is separated from the transverse sinus and the cerebellum by a plate of bone 3 t 6 mm. in thickness; the sinus is thus usually behind the antrum but sometimes it extends farther forwards and may even overlap the lateral side of the posterior part of the antrum The lateral wall of the antrum is formed by the post-meatal part of the squamous bone in which there is the slight depression of the supra meatal triangle; at the base of the triangle, close to the wall of the meatus, there is often a small supra meatal spine. At birth the bone is not more than 2 mm. in thickness, and the antrum is then, and remains in the hild, comparatively superficial. The suture between the squamous and petro-mastoid bones closes in the second year and thereafter the lateral wall of the antrum steadily increases in thickness; in the adult it is on the

average 15 mm. thick, but varies from 12 to 22 mm., and the antrum is that depth from the surface

The mastoid cells develop with the growth of the mastoid process which appears as a definite structure in the second year At first, when it is very small, the mastoid process is solid, but as it enlarges diploic bone appears in its interior As a general rule the diploic bone is replaced later at least in part, by the mastoid air cells, which develop from abov downwards and towards the periphery but the pneumatisation of the process varies greatly in its amount. The structure of the process in the adult thus varies. It may be entirely occupied by air cells which communicate with one another and the tympanic antrum, the central cells being the largest; or it may have air cells only in its central part and diploic tissue in its peripheral parts or it may be entirely filled with diploic tissue.

(The student is to examine the tympanic antrum and its relations and the structure of the mastoid process on prepared specimens.)

The anterior wall of the tympanic cavity is narrow In the upper part of it there is the opening of the canal for the tensor tympani muscle and below it the wide tympanic orifice of the pharyngo-tympanic tube (Fig 80) The canal for the muscle is to be opened by the removal of the roof which is the anterior part of the tegmen tympani in this way the tensor tympani muscle may be exposed. The bony septum between the muscle canal and the pharyngo-tympanic tube the processus cochleariformis, is very thin its posterior end extends backwards into the tympanic cavity above the promontory and serves as a pulley round which the tendon of the tensor muscle passes laterally to the handle of the malleus (Fig 80) Below the opening of the pharyngo-tympanic tube the anterior wall is formed by a thin plate of bone which separates the tympanic cavity from the carotid canal (Fig. 80)

The pharyngo-tympanic (Eustachian) tube is the passage through which the tympanic cavity communicates with the nasal part of the pharynx; through it air reaches the tympanic cavity and its antral and mastoid cell extensions and so equalises the pressure on the two sides of the tympanic membrane. It is directed forwards from the tympanic cavity and downwards and towards the middle line and is about one and a half inches in length. It consists of two parts, a bony part in the temporal bone and a fibro-cartilaginous part which lies on the exterior of the base of the skull and opens into the side wall of the naso-pharynx. The bony part is about half an inch long It is widest at its opening into the tympanic ca ity and gradually narrows as it passes forwards immediately above and lateral to the carotid canal, from which it is separated by a thin plate of bone. It ends on the base of the skull near the apex of the petrous part of the temporal bone, its orifice having a jagged margin t which the cartilaginous part is ttached this part will be dissected and described with the pharynx.

The medial wall of the tympanic cavity is to be more fully exposed by removing the tympanic membrane and the posterior wall of the external meatus. It intervenes between the tympanic cavity and the internal ear The anterior and greater part of its surface forms a rounded elevation named the promontory which is produced by the projection

outwards of the first turn of the cochlea. On it there may be seen small grooves for the lodgment of branches of the tympanic plexus of nerves (Fig 80) the plexus is embedded in the mucous membrane and its larger branches may be seen in it. Behind the upper part of the promontory there is an oval kidney-shaped foramen, the **foramen vestibuli** (or ovale) the long axis of which is directed antero-posteriorly it opens into the vestibule, the intermediate part of the bony labyrinth but in the recent state it is occupied by the foot piece of the stapes

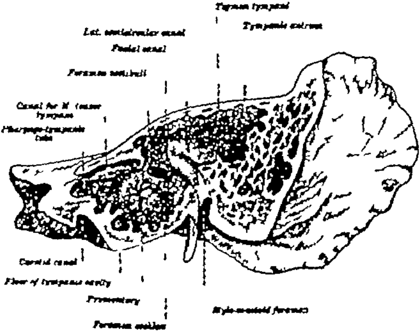


FIG 80.

A dissection of the middle ear from without. The descending part of the facial canal is indicated by broken lines. The processus cochleariformis, the folded shelf of bone between the canal for the tensor tympani and the pharyngo-tympanic tube is left to be coloured. The mastoid air cells are confined to the central part of the mastoid process, its apical part being occupied by diploic bone

which thus plays on the perilymph in the vestibule. Below and behind the promontory there is a round opening, the **foramen cochleae** (or rotundum) an aperture which leads into the cavity of the bony cochlea. In the recent state it is closed by a membrane named the **secondary tympanic membrane** Above the foramen vestibuli and lying in the angle at the junction of the roof and the medial wall (Fig 78) there is a rounded ridge running from before backwards this is the wall of the bony **facial canal** in which the facial nerve lies (Fig. 80) The wall of the canal is thin, and through it the white nerve can be seen.

The mucous membrane of the tympanic cavity pale thin, and tran parent is continuous with that of the pharynx through the pharyngo-tympanic tube and with that of th tympanic antrum and mastoid air cells behind It lines the walls of the tympanic cavity being closely adherent to the periosteum and the tympanic membrane. It also invests the ossicles, the tympanic muscles, and the chorda tympani nerve, a series of folds being formed which divide the cavity into pouch like spaces. The epithelium of the mucous membrane over the promontory the ossicles, and the tympanic membrane, and in the tympanic antrum and mastoid air cells, is a single layer of low cubical cells, but over the other parts, including the pharyngo-tympanic tube, it is a columnar ciliated layer

The course of the **facial nerve** through the temporal bone is to be studied at this stage of the dissection. With the auditory nerve, which lies below and behind it, it has already been followed into the internal auditory meatus (p 188) At the bottom of the meatus it enters the **facial canal** and in it passes through the petrous part of the temporal bone to the stylo-mastoid foramen. The roof of the internal meatus is to be chipped off with the chisel and mallet, and in it the facial and auditory nerves are to be defined. They run almost directly laterally the facial nerve being uppermost its small sensory root the pars intermedia which lies between the two great nerves, joins it in this part of its course. At the bottom of the meatus the facial nerve pierces the upper and anterior part of the lamina cribrosa, which closes the meatus, and enters the facial canal and in it it first passes laterally to reach the medial wall of the tympanic cavity This part of the canal is easily opened. It will then be seen that this part of the nerve is short, that it crosses over the internal ear in the interval between the cochlea and the vestibule (Fig 81) and that at its termination there is a small ganglion on it named the **geniculate ganglion** arising from the ganglion there can readily be found the **great superficial petrosal nerve.** It issues from the temporal bone through the hiatus canalis facialis on its upper surface from there its further course has been studied (p 187) Also arising from the ganglion there are con necting branches to the tympanic plexus and the small superficial petrosal nerve which arises from the plexus these however will not be found, though the markings of the plexus on the promontory are usually to be seen (Fig 80)

The facial nerve is now to be followed backwards from the geniculate ganglion by opening the lateral wall of the facial canal. At the ganglion the nerve bends at an acute angle on itself and runs backwards on the medial wall of the tympanic cavity above the foramen vestibuli. When it reaches the posterior wall of the tympanum the nerve turns down wards the bend here being an open curve on the medial wall of the aditus (Fig 80) and it then descends almost vertically with a slight lateral inclination to the stylo-mastoid foramen. As it turns downwards it gives off the nerve to the stapedius which enters the base of the pyramid and thus reaches the muscle. The vertical part of the nerve can be exposed by removing the necessary bone with a small saw and

the bone forceps and if the dissection is well made the chorda tympani will be seen taking origin from the nerve a short distance (6 mm.) above the stylo-mastoid foramen.

The chorda tympani is the largest branch which arises from the facial nerve in its course through the temporal bone. It arises near the stylo-mastoid foramen and runs upwards and forwards through the bone in a minute canal and enters the tympanic cavity through a foramen on its posterior wall below the pyramid and close to the inner surface of the posterior part of the tympanic membrane. It traverses the tympanic cavity on the upper part of the tympanic membrane, lying on its fibrous layer and under cover of its mucous membrane; it crosses the medial side of the handle of the malleus and was destroyed, therefore, when the malleus was removed. It passes above the tendon of the tensor tympani muscle and leaves the tympanic cavity through a foramen at the inner end of the petro-tympanic fissure and emerges on the exterior of the skull close to the spine of the sphenoid bone in the infra-temporal region. There it was found to join the lingual nerve and its fibres were followed in it to the submandibular ganglion and the tongue; the former fibres are secreto-motor fibres which are relayed in the ganglion to the submandibular and sublingual salivary glands, and the latter fibres are fibres of the sense of tast of the anterior two-thirds of the tongue. Its course in the temporal bone is difficult to follow unless the bone be decalcified, and should not be attempted by the student.

The parts of the bony labyrinth of the internal ear can be displayed only by careful and prolonged dissection which the student is unable to do he must be content, therefore, only to discover the main parts and demonstrate their relations to one another and on permanent specimens and enlarged models he should examine the details.

The superior semicircular canal is to be exposed by cutting away the back part of the eminentia arcuata in thin shavings with the chisel, and when exposed it is to be followed medialwards and lateralwards to demonstrate the size and shape of the canal and its lumen. The vestibule and the cochlea are then to be opened by chipping away the petrous temporal bone horizontally to about the level of the middle of the promontory on the inner wall of the tympanic cavity parts of the other semicircular canals will also be opened and their position and curves can be demonstrated by passing bristles into them.

The vestibule (Fig. 81) is a small irregularly ovoid cavity in the petrous temporal bone about 5 mm. in length; it is situated between the medial wall of the tympanic cavity and the bottom of the internal auditory meatus. The three semicircular canals open into it posteriorly and in its lower anterior part there is the opening of the scala vestibuli of the cochlea. On the lateral wall of the vestibule there is the foramen vestibuli which is occupied in the recent state by the foot plat of the stapes, and on the medial wall there are several groups of small foramina through which the filaments of the auditory nerve pass to the membranous labyrinth. There is there also the opening of the aquaeductus vestibuli, small canal which passes backwards and opens on the posterior surface of the petrous bone between the internal auditory

meatus and the groov for the sigmoid sinus; it permits the escape of excessive perilymph and lodges part of the membranous labyrinth.

The semicircular canals are three in number They lie posterior to the vestibule in planes at right angles to one another like three sides of a corner of a cube and suggest the three cardinal planes of the body—the coronal, sagittal, and frontal planes (Fig 81) They are named from their position the superior the posterior and the lateral canal Each canal forms con siderably more than half circle and opens by both ends into the back part of the vestibule; but as the adjoining ends of the superior and posterior canals are fused together in a common canal, the crus commune the total number of openings is reduced to five (Fig 81). One extremity of each canal is expanded into what is termed its ampulla.

The superior canal forms the highest part of the labyrinth. It is vertical

FIG. 91

The bony labyrinth of the internal ear from the lateral side The positions of the lateral semicircular canal, the facial canal, the foramina vestibuli and cochleæ, and the first turn f the cochlea are t be compared with the markings on the medial wall of the tympanic cavity (Fig. 80).

and lies almost in the coronal plane under the back part of the eminentia arcuata on the upper surface of the petrous bone; the eminence itself is a ridge which fits into a fissure of the brain. The posterior canal is also vertical and lies parallel with the posterior surface of the petrous bone and nearly in the sagittal plane The lateral canal lies in the horizontal plane it produces a longitudinal elevation on the medial wall of the aditus of the tympanic antrum bove the facial canal (Fig. 80).

The cochlea (Fig 81) has the form of a blunt cone, the base of which i turned towards the bottom of the internal uditory meatus and the apex, directed antero-laterally is close to the canal for the tensor tympani muscle It measures about one-fifth of an inch from base to apex and is about one-third of an inch broad t its base. The cochlea consists of a tapering tube which is coiled spirally for nearly two and three-quarter turns round a horizontal central pillar named the modiolus, the ppearance produced being similar to that of a spiral shell laid on its side. The modiolus, the central pillar of the cochlea, is thick at its base but tapers rapidly towards its apex. Its base

The chisel must then be used again to divide the base of the skull in the interval between the petrous part of the temporal bone and the basilar portion of the occipital bone that is, from the medial side of the jugular foramen forwards to the end of the transverse incision made with the chisel from below When this has been done the anterior

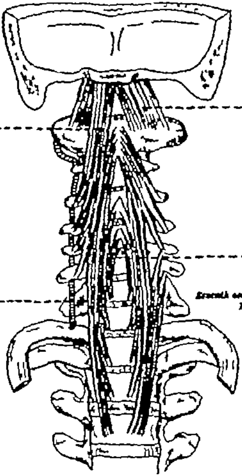


FIG 82.
Diagram of the pre-vertebral muscles of the neck. The vertebral artery is to be coloured.

part of the skull carrying the pharynx and the great blood vessels and nerves with it can be separated from the posterior part of the skull and the vertebral column the hypoglossal nerve is the only nerve to be divided. The specimen is to be wrapped in a moist cloth and laid aside until the pre-vertebral muscles, the vertebral artery and vein, and the articulations of the vertebral column and the cranio-vertebral joints have been examined.

laterally between the two muscles in each space and give branches to both of them their posterior rami turn backwards medial to or through the substance of the posterior muscles and give twigs to their medial parts. The upper two cervical nerves emerge over the posterior arch of the atlas and the vertebral arch of the axis.

The vertebral artery is to be exposed in its course through the transverse processes by removing the intertransverse muscles and the rectus lateralis and superior and inferior oblique muscles which are attached to the atlas. The foramina in the transverse processes are then to be opened with bone forceps.

The vertebral artery was previously exposed in the root of the neck (p. 113), where, as a branch of the first part of the subclavian artery it was followed as far as the transverse process of the sixth cervical vertebra into the foramen of which it disappears. It was exposed again in the sub-occipital triangle (p. 84) and was also seen in the dissection of the base of the skull, where after entering through the foramen magnum it was cut as it proceeds to its terminal distribution on the brain (p. 1"8). The part of the artery now exposed passes vertically upwards through the foramina in the transverse processes of the upper six cervical vertebræ, though in passing from the axis to the atlas it runs laterally rather than vertically to gain the more laterally placed foramen of the first vertebra (Fig 82) Between the transverse processes it lies medial to the intertransverse muscles and passes in front of the anterior rami of the cervical spinal nerves. It is surrounded by the vertebral venous plexus, which commences in the sub-occipital region and terminates below in the vertebral vein (p. 114), and is accompanied by a plexus of sympathetic nerves. Small spinal arteries have already been described to arise from it (p. 167), and these and small muscular twigs are its only branches.

THE VERTEBRAL AND CRANIO-VERTEBRAL JOINTS

The movable vertebræ are connected together by fibro-cartilaginous discs interposed between the bodies by diarthrodial joints between the articular processes and by several systems of ligaments some of which are attached to the bodies and some to the vertebral arches and their processes as already explained (p 80) a slight amount of movement is permitted between each two bones. The joints between the atlas and axis and the atlas and occipital bone, the cranio-vertebral joints at which the movements of the head take place, differ in their construction from the common inter vertebral joints below them the inter vertebral fibro-cartilages, for example are absent there are no true articular processes the ligaments are much stronger and a much greater amount of movement is possible at them. The common inter vertebral joints are to be examined first and then the specialised cranio-vertebral joints

The vertebral column is to be sawn across at the seventh cervical vertebra and all the muscle fibres are to be removed from the detached part. The articulations between the lower five cervical vertebræ are similar to one another and much the same in plan as those between

are then to be divided into lateral halves by a vertical saw-cut In this way the intervertebral fibro-cartilages can be examined A coronal section through one side will expose the small lateral diarthrodial joints (Fig 83)

The **intervertebral fibro-cartilages** are interposed between the bodies of the vertebræ from the axis to the sacrum; they constitute about one-fourth of the length of the column. They differ in thickness in different regions, being much the thickest in the lumbar region and thinnest in the mid-cervical region. The individual discs are thicker in front than behind in the cervical and lumbar regions and the curvatures of these parts are principally due to them In the thoracic region they are nearly of uniform thickness and the curvature is due to the shape of the bodies of the vertebræ. The peripheral part of each disc is tough and fibrous (annulus fibrosus) and consi ts chiefly of fibres running obliquely between the vertebræ; the central part is soft, elastic, and pulpy (nucleus pulposus).

2. The vertebral arches articulate by their articular processes the joints being diarthroses. The surfaces of the processes are covered with articular cartilage and a distinct though thin and loose fibrous capsule surrounds the joint cavity the capsules are strongest in the lumbar region and longest and thinnest in the neck. The arches are also bound together by the **ligamenta flava** and the **interspinous** and **supraspinous ligaments**, which are now to be examined on the specimen which was made when the arches were removed to expose the spinal cord (p. 167) There are also weak **intertransverse ligaments** which pass between the transverse processes.

The supraspinous ligaments are strong fibrous bands which connect together the apices of the spinous processes and form a continuous series from the seventh cervical vertebra to the sacrum They are thicker in the lumbar than in the thoracic region. In the neck they are replaced by the ligamentum nuchæ.

The **ligamentum nuchæ** is a band of white fibrous tissue which extends from the spinous process of the seventh cervical vertebra to the external occipital protuberance and crest, and is connected with the spines of the intervening ertebræ. It is to be considered as an upward continuation of the supraspinous ligaments of the thoracic region. It lies between, and gives origin to, the muscles of the tw sides of the neck (Fig 4) In som of the quadruped mammals it is greatly developed and is composed of yellow lastic tissue and thus helps to sustain the weight of the head.

The **interspinous ligaments** are thin and membranous and connect together the djoining spinous processes, their attachments extending from the root to the apex of each process. They are best developed in the lumbar region in the neck they are incorporated in the ligamentum nuchæ

The **ligamenta flava** (Fig 84) connect the laminæ of adjacent vertebræ and are best seen from the side which faces the interior of the vertebral canal, of which, with the laminæ, they form the posterior wall. They are attached above and below along the whole length of the laminæ so that th posterior borders of opposite ligaments come into conta t in the middle line; the slit like interval which is left between them gives passage to small veins

The ligaments are composed of yellow elastic tissue, the fibres of which run almost vertically between their attachments. Their elasticity which can be tested by stretching the specimen, makes them a valuable aid to the muscles in restoring the vertebral column to the upright position after it has been bent forwards.

The movements of the vertebral column are described on p. 80.

The cranio-vertebral joints, at which the movements of the head take place, are the diarthrodial joints between the atlas and axis and the atlas and occipital bone, and in connexion with them the common ligaments of the vertebræ below are continued upwards in specialised form. The specimen is first to be examined from the front and on

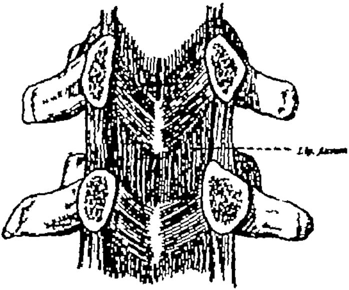


Fig. 84.

The ligamenta flava as seen from the vertebral canal.

it the upward continuation of the anterior longitudinal ligament is to be defined. It forms the anterior atlanto-axial and anterior atlanto-occipital membranes.

The anterior longitudinal ligament of the lower vertebræ is continued upwards from the body of the axis to the anterior arch of the atlas to which it is firmly attached; this extension of it forms the anterior atlanto-axial membrane (Fig. 85). It is thick and strong in the middle but thin and membranous at the sides. It is continued above the atlas as the anterior atlanto-occipital membrane, which extends from the upper margin of the anterior arch of the atlas to the anterior surface of the occipital bone in front of the foramen magnum (Fig. 85). It also is much thicker in the middle than at the sides.

The specimen is now to be examined from behind. There will be seen on it in the interval between the laminæ of the axis and the posterior arch of the atlas the uppermost of the **ligamenta flava**; it is known as the **posterior atlanto-axial membrane** and is pierced by the second cervical nerve. The inter-laminar ligaments are continued upwards and fill the interval between the posterior arch of the atlas and the posterior margin of the foramen magnum; this part is known as the **posterior atlanto-occipital membrane** (Fig 85). It is a thin membranous sheet, the lateral border of which arches over the groove behind the articular mass of the atlas in which the vertebral artery

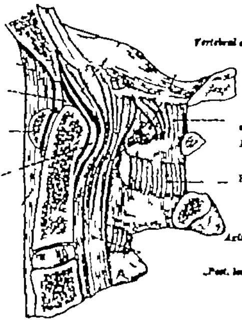


FIG. 85.

A longitudinal section in the middle line to show the ligaments of the cranio-vertebral joints. The ligaments are to be coloured as they are dissected.

and the sub-occipital nerve pass. Not uncommonly this part of the membrane is ossified and converts the groove into a foramen.

The **atlanto-occipital joints** between the occipital condyles and the lateral masses of the atlas and the **atlanto-axial joints** between the atlas and the upper articular processes of the axis are surrounded by weak connective tissue capsules (Fig 86). They are to be removed to expose the joint surfaces, and it is then to be demonstrated that the nodding movements of the head occur at the upper joints and the side to side movements at the lower joints.

There is a further articulation between the axis and the atlas, namely that between the odontoid process of the axis and the posterior

surface of the anterior arch of the atlas (Fig 85). It is to be exposed from behind. It is necessary therefore to remove with the bone forceps the laminæ of the axis and the posterior arch of the atlas, and then to cut away the squamous part of the occipital bone so that the foramen magnum is freely opened (Fig. 86). This dissection having been completed the upper part of the spinal cord is to be examined

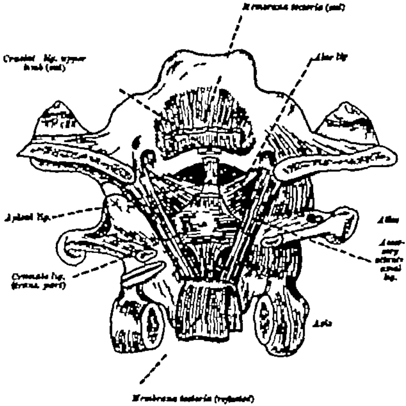


FIG 86.

A dissection of the cranio-vertebral joints from behind. The membrana tectoria is cut and turned down; the articular capsules are preserved on the right side; the accessory atlanto-axial ligaments are irregularly continued to the occipital bone the apex of the odontoid process is at the lower end of the apical ligament.

and the origin of the spinal part of the accessory nerve from it defined. The roots of the first and second cervical nerves are to be cut and the cord removed. A broad membrane will be exposed stretching upwards from the posterior surface of the body of the axis on which it is continuous with the posterior longitudinal ligament of the vertebræ below it extends over the odontoid process and through the foramen magnum to be attached on the upper surface of the basilar process

of the occipital bone (Fig 85) It is known as the **membrana tectoria.** It is to be cut through and turned upwards and downwards and its attachments defined (Fig 86) When this is done there will be brought into view the **cruciate ligament** and the **accessory atlanto-axial ligaments,** the former of which especially is to be carefully studied (Fig 86).

The cruciate ligament consists of a transverse and a vertical part The transverse part is a thick strong band which is attached on each side to a tubercle on the medial face of the lateral mass of the atlas, and, stretching across the ring of the atlas, it holds the odontoid process in contact with its anterior arch. Between it and the odontoid process there is a synovial cavity which is more extensive than the cavity between the process and the arch of the atlas. The vertical part of the ligament, variable in its thickness, extends upwards and downwards from the middle of the transverse part (Fig 86) Its upper limb is attached above to the basilar part of the occipital bone just within the foramen magnum, while its lower limb much shorter, is fixed to the posterior surface of the body of the axis.

The accessory atlanto-axial ligaments (Fig 86) take origin from the atlas just behind the transverse ligament and run obliquely downwards and medially to be attached to the back of the body of the axis close to the base of the odontoid process; in the specimen figured their upper attachment is to the occipital bone.

The upper limb of the cruciate ligament is to be cut away to bring the odontoid process into view (Fig 86) From the apex of the process the **apical ligament** will be seen passing up to the anterior edge of the foramen magnum it is of considerable morphological interest since it is formed round the notochord and its sheath. The **alar** (or check) **ligaments** will also be exposed (Fig 86) They are strong bands passing laterally and a little upwards from each side of the summit of the odontoid process to the medial sides of the occipital condyles. They can carry the whole weight of a child's body as when it is lifted by the head.

The Movements of the Head.—The articular surfaces of the cranio-vertebral joints are to be exposed by dividing the ligaments between the bones and separating them from one another; then, by fitting them together it is possible to understand the mechanism of the movements of the head.

The rotatory (side to side) movements of the head take place at the atlanto-axial joints, the head with the atlas rotating round a vertical axis which passes through the odontoid process; the range of movement is about 30° to each side but can be much increased by movement of the cervical vertebræ. The median joint—between the odontoid process and the anterior arch of the atlas—is a vertical hinge joint, closely resembling the superior radio-ulnar joint it permits pure rotation round a vertical axis. The movement here is accompanied by gliding movement at the lateral atlanto-axial joints, the gliding being in opposite directions on the two sides; and the surfaces are so shaped that they come more fully into contact when the head is turned and there is then slight descent of the atlas. The descent of the atlas relaxes the alar ligaments so that they do not check the movements as early as they would otherwise do.

The flexion and extension (nodding) movements and the lateral bending movements of the head take place at the atlanto-occipital joints; their range is not great but is greatly increased by accompanying movements of the cervical vertebræ. The two atlanto-occipital joints form a mechanical unit *in which movements take place round a transverse and an antero-posterior axis*. The antero-posterior axis is tilted upwards in front and the lateral bending movements are therefore combined with slight turning of the head to the opposite side. The position of greatest stability at the joints is that in which the head is most naturally carried, that is, bent slightly to one side and turned a little to the opposite side.

The Muscles which Act on the Head.—The movement of flexion is ordinarily brought about by the weight of the head, for the weight axis of the head lies slightly in front of the transverse axis of movement at the atlanto-occipital joints; the head is maintained in the erect position by the postural activity of the extensor muscles. Active flexion against resistance is produced by the sterno-mastoid and the pre-vertebral muscles attached to the skull; they flex the head directly forwards when both sides act together but bend it obliquely and with a turning action when those of one side act alone. The action of the sterno-mastoids is seen best when a subject lying flat on the back raises the head; then they powerfully contract and the rectus muscles of the abdominal wall contract with them to fix the sternum. The movement of extension is initiated by the post-vertebral and trapezius muscles, but after the weight of the head is carried behind the axis of gravity the movement is controlled by the flexor muscles.

The muscles which effect the rotatory movements of the head, say turning the face to the left side—which is accompanied by a slight bending of the head to the right side—are the right sterno-mastoid, the upper part of the right trapezius, and the left splenius capitis; the short muscles between the axis and atlas and the atlas and occipital also contract to fix the head and the atlas on the axis, and the left omo-hyoid contracts to ensure that the hyoid bone moves with the chin.

THE MOUTH AND PHARYNX

The dissectors must now turn to the specimen which was laid aside while the prevertebral region was being dissected; on it there are to be studied the mouth and pharynx and the nose and larynx, the upper ends of the digestive and respiratory systems.

The Mouth

The mouth is to be examined first, and the student should confirm the findings in the subject by an examination of his own mouth in a looking-glass. The cavity of the mouth consists of two parts, namely that part, the vestibule, which is between the lips and cheeks externally and the gums and teeth internally, and that part, the mouth proper, which is within the teeth.

The vestibule is a narrow cleft, unless the cheeks are inflated or the muscles of the face which control its cavity are paralysed, and so long as the teeth are closed communicates with the mouth proper only through the gaps behind the last molar teeth and in front of the rami of the mandible. The roof and floor of the vestibule are formed by the

reflections of the mucous membrane from the lips and cheeks to the gums—which they join at the level of the middle of the roots of the teeth in the middle line of the reflections there are small vertical folds the **labial frenula**, the upper of which is the larger The parotid duct opens into the vestibule on a small papilla opposite the upper second molar tooth it can often be felt with the tip of the tongue. There also open into the vestibule the mucous glands of the lips and cheeks.

The structure of the lips has already been examined (p 36) and the student is now only reminded that the layers which enter into their formation are the skin and the mucous membrane which cover the outer and inner surfaces and become continuous with one another on the free margin the muscles which constitute the chief bulk of the lips and the small labial glands which lie between the muscles and the mucous membrane. The blood supply of the lips is described on p 44 and the nerve supply on p 49 the lymph vessels of the upper lip pass to the superficial parotid and submandibular glands and those of the lower lip to the submandibular and submental glands. The **cheeks** have the same general structure as the lips they also have been dissected but the **buccinator muscle** (Fig 91) remains in position. It is covered on its surface by the remains of the **bucco-pharyngeal fascia** which is attached above and below to the alveolar margins of the maxilla and mandible and is continued backwards over the wall of the pharynx. The **parotid duct** (Fig 43) can still be secured it pierces the fascia the buccinator muscle, and the mucous membrane of the cheek, and its opening opposite the upper second molar tooth should now be found by everting the cheek.

The **gums** (gingivæ) are those parts of the mucous membrane of the mouth which cover the alveolar arches of the jaws and surround the necks of the teeth their submucous layer is dense fibrous tissue which is closely adherent to the periosteum of the bones. The student is to reflect part of the gum to expose this layer and to appreciate the thickness of the gum.

The form and arrangement of the **teeth** are to be studied on permanent specimens in the bone-room and their dates of eruption are to be learnt from a text-book but the student is to make himself familiar with their gross structure and the manner of their implantation in the alveoli of the jaws by making with a saw a longitudinal section through a front tooth of the mandible, the bone being cut with the tooth (Fig. 87)

A tooth has three parts, namely the crown, the neck, and the root. The crown is coated with enamel and projects above the gums its shape is the basis of the classification of the teeth as incisor canine, bicuspid, and molar teeth. The neck is the constricted part of the tooth which is embraced by the gum, and the root or fang is the part, covered with cement which is fixed in the alveolus or socket; the bicuspid and molar teeth have two or more roots, each of which occupies its own alveolus.

The bulk of the tooth consists of dentine, a hard bone-like tissue devoid of blood vessels but supplied with sensory nerves. It surrounds a central cavity the pulp chamber, which is filled with the pulp, a soft areolar tissue in which

are the dental blood vessels and nerves; they enter the pulp through the apical foramen at the end of the root. The crown of the tooth is covered with a thin layer of enamel, an extremely hard calcified substance in which there is almost no organic matter. It gradually thins away towards the neck of the tooth, round which its terminal border forms a distinct edge. The neck and root of the tooth are surrounded with cement, a slightly modified osseous tissue. It begins where the enamel ends as a thin layer (0·03 mm. thick) and increases in thickness until over the lower part of the root it may be 2 mm. thick.

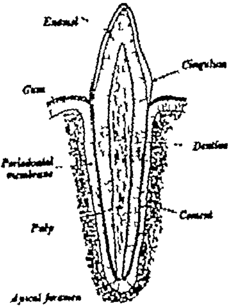


Fig. 87

A vertical section of a front tooth in position.

The root of the tooth is fixed to the walls of the alveolus by the periodontal membrane, a vascular fibrous layer which on the one side is the periosteum of the bone and on the other the pericementum of the cement. The fibres of the membrane run almost horizontally at the neck of the tooth and form there a pericervical ligament which prevents the spread of infective material from the mouth downwards round the root; lower down the fibres are more oblique, and at the apex of the root they form a loose connective tissue. The articulation of the tooth in its socket is a gomphosis (see Vol. I., p. 39).

The mouth proper is bounded in front and at the sides by the teeth and the gums; its roof is vaulted and is formed by the hard and soft

palate and it opens posteriorly into the pharynx through the oro-pharyngeal isthmus. These parts are to be examined on the specimen by cutting the buccinator muscles backwards from the angles of the mouth to the pterygo-mandibular ligaments and so fully exposing them and the student is also to examine them on himself with a looking-glass

The roof of the mouth is formed by the palate which consists of two parts, the hard palate in front and the soft palate behind; hanging from the middle of the soft palate behind and resting on the dorsum of the tongue there is a

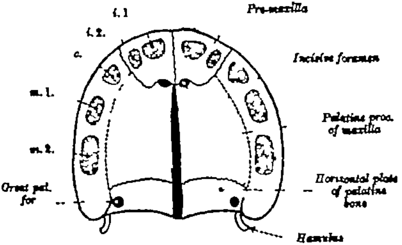


FIG. 88.

A diagram of the construction of the hard palate.

small conical process, the uvula. Along the middle line of the hard palate, which will require to be cleaned, there is a linear raphe which ends anteriorly in the interval between the central incisor teeth in a small papilla, named the incisive papilla since it is opposite the incisive canal of the maxillary bone. Over the front part of the palate the mucous membrane is thrown into four or five transverse folds or rugæ, but behind this it is smooth and of a paler colour. The rugæ are best developed in fœtal life and become less distinct and may even disappear with age; they assist the young in holding the nipple when sucking. At the postero-lateral angle of the hard palate, behind the lingual surface of the last molar tooth, the pterygoid hamulus can be felt. It is directed postero-laterally. The student is to identify it on the specimen and by gentle pressure break it on one side; and he is to feel it on himself with the tip of the tongue.

The palate as a whole is concave from before backwards and from side to side but there are great individual differences in its width and the amount of its arching; in some it is broad and nearly flat and in some narrow and highly arched. The differences are due to differences in development of the masticatory and respiratory parts of the face.

The osseous framework of the hard palate—*the construction of which is to be studied on the dried skull*—is formed by the palatine processes of the maxillæ and the horizontal plates of the palatine bones; between the front parts of the maxillæ and early fused with them, is the pre-maxilla (Fig. 88). The palatine processes of the bones grow inwards from the sides and fuse with one another and the lower edge of the nasal septum from before backwards in the middle line, as the student will learn from the text-book; the lateral halves of the uvula are the last parts to fuse. Failures of fusion are not uncommon; they are represented by the several grades of cleft palate.

The under surface of the hard palate is covered with a tough mucous membrane and periosteum, the two layers being firmly fused to form a muco-periosteum; there are numerous mucous glands in its posterior part. The *muco-periosteum is easily removed from the bones; the student is to* demonstrate this for himself. The vessels and nerves of the mucous membrane, from the maxillary artery (p. 206), and the spheno-palatine ganglion of the maxillary nerve (p. 203) enter it through the great palatine and incisive foramina; it is not necessary to dissect them.

The oro-pharyngeal isthmus (isthmus of the fauces) is the aperture through which the mouth opens into the pharynx; the examination of it is best made on the living subject. The isthmus is bounded above by the soft palate, below by the back part of the tongue, and at the sides by curved folds of *mucous membrane named the palato-glossal arches (anterior pillars of the fauces).* The arches descend with a forward inclination from the back of the under surface of the soft palate and end on the sides of the back of the tongue; they contain the palato-glossus muscles, as will be seen later when they are dissected.

A second pair of arches, the palato-pharyngeal arches (posterior pillars of the fauces), can be seen behind the palato-glossal arches when the mouth is widely open; they belong to the lateral wall of the pharynx, as also do the tonsils which lie between the two arches of each side.

The floor of the mouth or submandibular region has already been dissected from below. It was then seen to be formed, under the skin and the fasciæ, chiefly by the mylo-hyoid muscles which stretch like a diaphragm from one side of the mandible to the other and to have incorporated in its back part the root and lower part of the sides of the tongue; and lying on the upper surface of the mylo-hyoid muscle and at the sides of the tongue are the deep parts of the submandibular glands and the sublingual glands. As seen from the mouth these structures are covered by the mucous membrane of the floor of the mouth, the tongue rising upwards in the back part of the cavity of the mouth and carrying the mucous membrane with it; there the mucous membrane is reflected from the sides of the tongue to the gums. The anterior part of the tongue, however, is free and lies on the floor of the mouth, though its under surface is connected to it by a median fold of mucous membrane, the frenulum; if it is over-developed the

tongue is more fixed than is required for sucking On each side of the floor of the mouth between the side of the t ngue and the gum the **sublingual fold** (plica sublingualis) can be seen (Fig 89) it is produced by the sublingual gland (Fig. 52) At the anterior end of the sublingual fold on a small papilla close to the *frenulum, there is the orifice of the* submandibular duct and on the fold itself there are the openings of the sublingual ducts (p 142)

The **tongue** has already been described to be essentially a muscular organ and to contain in the mucous membrane which covers it large numbers of taste buds, the peripheral organs of taste. Its movements are concerned with the acts of chewing, swallowing and speaking when at rest and the mouth is closed it is moulded into the vaulted arch of the palate and fills the cavity of the mouth. It is attached to

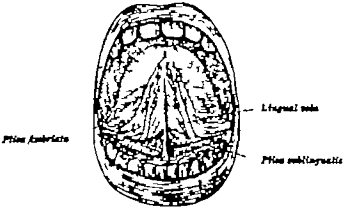


FIG. 89

The under surface of the tongue and the anterior part of the floor of the mouth The openings of the submandibular ducts are at the anterior ends of the plicæ sublinguales and the frenulum of the tongue is between them.

the hyoid bone the styloid processes, the mental tubercles of the lower jaw and the soft palate by its extrinsic muscles which enter it from below and it is bound to the floor of the mouth and the epiglottis by the reflections of its mucous membrane The mucous membrane which covers the muscle substance is shaped like an inverted shoe and its vessels and nerves enter the inferior opening in it with the extrinsic muscles

The mucous membrane which lines the mouth, vestibule and mouth proper and covers the gums and the tongue has a stratified squamous epithelium as in the skin (Vol. I p. 16) The superficial cells are cornified and are con tinually being shed; they are to be seen in abundance in preparations of the mouth fluids. The sub-epithelial layer is identical in structure with the dermis of the skin (Vol. I p 17), and consists of white fibrous tissue with some lastic tissue It is prolonged into papillæ which project into the epithelium. The papillæ contain loops of blood vessels and a rich plexus of lymph capillaries

but sensory nerves are scarce; the gum indeed is very poorly supplied. The layer on which the mucous membrane rests is composed of strong bundles of white fibrous tissue which, over the bones, is fused with the periosteum.

The upper surface or dorsum of the tongue is divided by a V-shaped groove, the sulcus terminalis, into two developmental parts, an anterior oral part which forms about two-thirds of the organ and when the *tongue is at rest is applied to the palate, and a posterior pharyngeal* part which forms the anterior wall of the oral part of the pharynx. The apex of the sulcus terminalis is directed backwards and at it there is a small blind pit, the foramen caecum, which is the remains of the upper part of the thyro-glossal duct (p. 169) and the two limbs of the sulcus, passing forwards, reach the margins of the tongue at the attachments of the palato-glossal folds. The mucous membrane on the two parts of the tongue is different in appearance and structure and its nerve supply is derived from different nerves. The membrane which covers the pharyngeal part is thick and smooth and glossy in appearance. Its surface is studded with low flat elevations which are produced by underlying masses of lymphoid tissue, often called the lingual tonsil; in the centre of each elevation a small pit can usually be seen. The mucous membrane of the anterior two-thirds is thin, closely adherent to the muscle below and covered with papillae. They are of different kinds. The largest and most distinctive are the circumvallate papillae, eight to twelve in number, which are placed along the anterior margin of the sulcus terminalis; there is usually a large median papilla just in front of the foramen caecum. Each papilla consists of a central cylindrical part surrounded by a deep trench, the outer wall of which is raised above the general level of the surface; taste buds are found on both walls of the trench. The tongue is to be depressed and pulled well forwards and cleaned that the papillae may be examined; and the student is to study them on his own tongue. He is also to note the shallow median groove which runs from the foramen caecum to the tip of the tongue and divides the oral part into lateral halves.

The fungiform papillae are smaller and much more numerous than the circumvallate papillae. They are scattered irregularly but are particularly gathered at the tip and the sides. They are globular in form, constricted at their attached ends, and are easily distinguished in the living person by their deep red colour; they have a rich sensory nerve supply. The conical papillae are closely set over the whole surface of the anterior two-thirds of the tongue. They are minute projections, conical in shape, and are arranged in rows parallel with the lines of the circumvallate papillae at the back part but more transverse towards the tip of the tongue. The filiform papillae are similar in shape to the conical papillae but are finer and their apical filamentous parts are whitish in colour. The conical and filiform papillae are covered with thick cornified epithelium and serve mechanical purposes in the action of the tongue on food.

The mucous membrane on the under surface of the tongue is smooth and shining and so thin that in the living person the veins

of the tongue can be seen through it. In the middle line the mucous membrane forms the frenulum and on each side of it there is a fold the edge of which occasionally presents a row of fringe-like processes it is named the plica fimbriata (Fig 89) The mucous membrane is to be removed from the under surface to expose near the tip of the tongue beneath a thin covering of muscle fibres, a group of glands aggregated together to form an oval mass about half an inch long they are the glands of Blandin and Nühn. They open by a number of ducts on the under surface of the tongue On the side of the tongue, immediately in front of the attachment of the palato-glossal arch, there are four or five short vertical folds in the mucous membrane they are named the folia linguae. They contain taste buds.

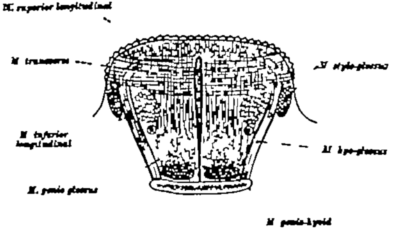


Fig. 90

Diagram of a transverse section of the tongue to show the arrangement of the intrinsic muscles; the vertical fibres are not named. The thickness of the median septum is exaggerated.

The extrinsic muscles of the tongue are to be identified and by removing the mucous membrane they are to be followed into the tongue to demonstrate the manner in which their fibres mingle with those of the intrinsic muscles. The nerves of the tongue namely the hypoglossal nerve which supplies the muscles and the lingual and glosso-pharyngeal nerves which are distributed to the mucous membrane of its anterior two-thirds and posterior third, are to be traced as far as possible towards their terminations. The circumvallate papillae are supplied from the glosso-pharyngeal nerve which is a nerve of taste and common sensation the lingual nerve carries the chorda tympani.

Several transverse sections are now to be made through the tongue from before backwards. It will be seen on them that the tongue is divided into lateral halves by a vertical median septum of fibrous tissue (Fig 90). The septum extends the whole length of the tongue

from its attachment to the hyoid bone behind to its apex in front, and though it does not extend through the superior longitudinal intrinsic muscle (Fig. 90) it forms a remarkably complete partition between the two sides and there is little anastomosis through it between the two lingual arteries. These vessels are to be recognised on the sections, and then the general arrangement of the fibres of the intrinsic muscles should be studied. They are confined to the tongue and produce therefore alterations in its form rather than in its position. All of them are supplied by the hypoglossal nerve.

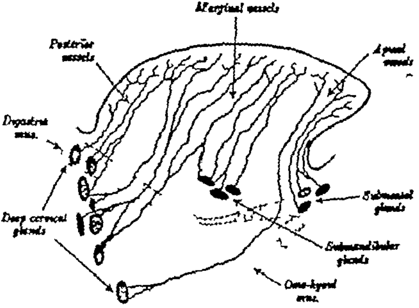


Fig. 90A.

A diagram of the lymph drainage of the tongue.

The intrinsic muscles of the tongue are arranged in four groups of fibres (Fig. 90) (1) The superior longitudinal fibres form a thin stratum over the whole dorsum of the tongue immediately underneath the mucous membrane. (2) The inferior longitudinal fibres form two bundles, one on each side, on the under surface of the tongue from the root to the tip; posteriorly each of them lies in the interval between the hyoglossus and genio-glossus muscles. (3) The transverse fibres arise from the median fibrous septum and pass laterally to the sides of the tongue; intermingled with them there are layers of fatty areolar tissue. (4) The vertical fibres extend from the dorsum to the under surface of the fore part of the tongue in curved bands concave laterally.

The lymph vessels of the tongue cannot be seen in the dissection and the lymph glands of the neck in which they end have been removed

they are so important, however in all diseases of the tongue that the student is to be careful to study the descriptions of them.

The lymph vessels of the tongue are large and numerous and allow a free spread of infection. They are arranged in two systems namely (1) the superficial vessels which form a rich plexus in the submucous tissue on the dorsum and sides of the tongue, and (2) the deep vessels which are arranged as a network in the musculature of the tongue. The two systems are in free communication with one another and across the middle line of the tongue. They are drained by four sets of lymph vessels to the lymph glands of the neck (Fig 90A). (1) The apical vessels drain the tip and the inferior free surface of the tongue They descend on the genio-glossus muscle and pierce the mylo-hyoid muscle and end chiefly in the submental glands; but some of them pass directly to the jugulo-omo-hyoid gland of the deep cervical group (p. 109, Fig. 40) (2) The marginal vessels drain the submucous plexus on the dorsum and side of the anterior two-thirds of the tongue They pass downwards mostly on the superficial surface of the hyo-glossus muscle and pierce or pass behind the mylo-hyoid muscle and end in the submandibular glands and the glands of the deep cervical group which stretch from the digastric to the omo-hyoid muscle; the chief tongue gland of this group lies at the bifurcation of the common carotid artery (3) The posterior vessels drain the submucous plexus of the posterior third of the tongue. They pierce the wall of the pharynx below the tonsil and end in upper deep cervical glands, again mainly in the chief tongue gland. Many of the medial vessels pass from one side of the tongue to the opposite side of the neck. (4) The central vessels drain the middle part of the dorsal submucous plexus and the deep plexus, the vessels of each side coming from both halves of the tongue. They descend between the genio-glossus muscles and then run backwards with the veins of the tongue and end in the upper deep cervical glands.

The Pharynx

The pharynx is a wide tube, conical in its general form the base being at the base of the skull and the apex at the sixth cervical vertebra there at the lower border of the cricoid cartilage it becomes continuous with the œsophagus. It is about five inches in length. It is placed behind the nasal cavities, the mouth and the larynx all of which open into it, so that it conducts air from the nose to the larynx as well as food from the mouth to the œsophagus (Fig 92) The pharyngo-tympanic tubes also open into it, at its upper part, and through them it communicates with the tympanic cavities.

The general relations of the pharynx have already been studied. It rests posteriorly on the basi-occipital bone and the upper six cervical vertebræ covered by the pre-vertebral muscles and the pre-vertebral fascia it is bound to the fascia by loose connective tissue which does not hinder the movements of its walls On each side it is related to the great vessels and nerves of the neck and to the styloid process and the muscles which arise from it, while above it is attached to the base of the skull Its anterior wall is interrupted by the openings of the nasal cavities, the mouth and the larynx, to the margins of each of which it is attached its principal attachments there, from above

downwards, are the medial pterygoid plate the side of the tongue, the inner surface of the mandible, the hyoid bone and the thyroid and cricoid cartilages.

When it is at rest the pharynx is compressed from before backwards, so that as seen in transverse section its anterior wall is approximated to its posterior wall its upper part has then a small lumen to allow the passage of air but below the orifice of the larynx its walls are in contact. It is expanded by the passage of food. It is advisable to distend the pharynx moderately with tow which should be introduced from above to make a dissection of its walls.

The **wall of the pharynx** consists of three layers namely an external **muscular layer** which is covered by a layer of fascia, the **bucco-pharyngeal fascia** an intermediate **fibrous layer**, the **pharyngeal aponeurosis** and the **mucous membrane** which lines the interior

The muscular layer comprises three circularly disposed muscles named the **constrictor muscles**, and, deep to them, the **stylo-pharyngeus** and **palato-pharyngeus muscles** which are directed longitudinally The constrictor muscles are to be cleaned from below upwards by removing the covering of fibrous tissue the **bucco-pharyngeal fascia**, which invests them and covers the back part of the buccinator muscles and while this is being done numerous small anastomosing veins will be met between the fascia and the muscles. These veins constitute the **pharyngeal venous plexus** which drains the pharynx and the soft palate it communicates with the pterygoid plexus and the cavernous sinus (p 183) and from it two or three descending veins drain into the internal jugular vein. The **pharyngeal plexus of nerves** will be removed with the veins. It is formed as already described (p 154) by the pharyngeal branches of the glosso-pharyngeal and vagus nerves and the cervical sympathetic cord, and it supplies the muscles and the mucous membrane of the pharynx the fibres in the branch of the vagus are derived from the medullary part of the accessory nerve (p. 157) The three **constrictor muscles** can now be seen to be curved sheets, which arise in front from the cartilages of the larynx, the hyoid bone the mandible and the medial pterygoid plate and, greatly expanding as they pass backwards they join their fellows of the opposite side in a posterior median fibrous raphe and they are so arranged that they overlap one another from below upwards The attachments of each muscle are to be examined. The constrictor muscles are composed of striped muscle fibres, and have their innervation from the medullary part of the accessory nerve which reaches them through the pharyngeal branch of the vagus and the pharyngeal plexus the inferior constrictor often receives some fibres from the recurrent laryngeal nerve.

The **inferior constrictor muscle** (Fig 91) arises from the side of the cricoid cartilage the inferior cornu and oblique line on the lamina of the thyroid cartilage and fibrous raphe between the two cartilages. The fibres spread backwards to be inserted with those of the opposite side into the fibrous

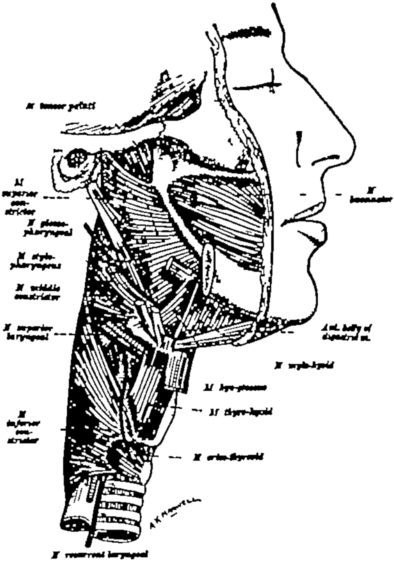


FIG. 91.

A dissection of the wall of the pharynx and the related parts. The levator palati muscle can be seen behind the tensor palati; the parotid duct is shown piercing the buccinator muscle; and between the buccinator and the superior constrictor of the pharynx is the pterygo-mandibular ligament. The superior and inferior laryngeal arteries are to be coloured and named.

between them on the base of the skull the cartilaginous part of the **pharyngo-tympanic** (Eustachian) **tube** is to be felt and then defined.

The **stylo-pharyngeus muscle**, the strongest of the three styloid muscles, is to be followed into the wall of the pharynx by removing the covering parts of the middle constrictor It gradually expands and having been joined by the palato-pharyngeus ends on the upper and posterior borders of the thyroid cartilage and in the lateral wall of the pharynx (p. 148) The removal of the muscles will expose the **pharyngeal aponeurosis**, and it will be seen that it is much stronger in its upper part, where the muscles are absent, than it is below

The lower end of the pharynx is continued into the **œsophagus** at the lower border of the cricoid cartilage this lies at the level of the sixth cervical vertebra. The junction is about six inches (15 cm.) distant from the incisor teeth, and at it the lower edge of the inferior constrictor overlaps the beginning of the œsophagus it is to be reflected upwards that the wall of the cervical part of the œsophagus may be examined.

The wall of the œsophagus consists of an external muscle coat, a middle areolar or submucous coat, and an internal mucous membrane. The muscle coat consists of an external longitudinal layer and an internal circular layer as is the prevailing arrangement in the whole length of the digestive canal. The muscles of the cervical part of the œsophagus are composed of striped fibres they are gradually replaced by unstriped visceral fibres which alone are present in its lower part. The longitudinal fibres arise by a flat tendon from the back of the cricoid cartilage and spread round the sides and back of the œsophagus as they descend; they leave bare a triangular area t the upper part of the posterior wall (Fig. 50) at which, thus weakened, diverticula may occur The circular fibres are attached in front to the back of the cricoid cartilage and are partly blended with th lowest fibres of the inferior con strictor they form a functional sphincter which constricts the beginning of the œsophagus, and it is subject to conditions of spasm.

The pharynx is to be opened by a median incision through the entire length of its posterior wall and a cross cut close to the base of the skull the longitudinal incision is to extend through the œsophagus. The packing is to be removed and the cavity washed. The **mucous membrane** of the pharynx is exposed. It is continuous with the linings of the cavities which open into the pharynx and is characterised by large numbers of mucous glands and small lymph follicles in *certain* situations the lymph follicles are aggregated into large masses, for example the tonsils and the naso-pharyngeal tonsil. The epithelium covering its upper part (the naso-pharynx) is columnar and ciliated but the lower parts have stratified squamous epithelium.

The soft palate will be seen projecting into the pharynx. It divides the cavity of the pharynx into an upper part, the **naso-pharynx**, which communicates with the na al cavities, and a lower part which consists of an **oral pharynx** posterior to the mouth and a **laryngeal pharynx** posterior to the larynx.

raphe in the middle line of the posterior wall of th pharynx. The lower fibres are horizontal, or even curve downwards, but those above ascend with an increasing obliquity and the highest fibres terminate only a short distance from the base of the skull. The lower margin of the muscle overlaps the upper end of the oesophagus, and *running under it are the inferior laryngeal* nerve and the laryngeal branch of the inferior thyroid artery on their way to the larynx.

The middle constrictor muscle arises under cover of the hyo-glossus from the great and small cornua of the hyoid bone and the lower end of the stylo-hyoid ligament. The fibres diverge widely as they pass backwards, the lower descending beneath the inferior constrictor and the upper ascending and overlapping the superior constrictor; they are inserted into the posterior median raphe long nearly the whole length of the pharynx. In the anterior part of the interval between the middle and inferior constrictors the internal laryngeal nerve and the accompanying artery will be seen piercing the thyro-hyoid membrane to gain the interior of the larynx (Fig. 60).

The superior constrictor muscle is thinner and paler than the lower constrictors. It is a quadrilateral muscle which arises by a continuous origin from the side of the tongue, the mucous membrane of the mouth, the posterior end of the mylo-hyoid ridge of the mandible the pterygo-mandibular raphe which is common to it and the buccinator muscle (Fig. 91), and the hamular *process and the lower third of the posterior border of the medial pterygoid* plate. The internal pterygoid muscle will require to be removed to bring the origin fully into view The fibres curve backwards to the median raphe and the uppermost of them are prolonged upwards with it to be attached to the pharyngeal t bercle on the under surface of the occipital bone. The lower part of the muscle is overlapped by the middle constrictor and passing into the interval between them is the stylo-pharyngeus muscle.

The pterygo-mandibular raphe is trong though narrow tendinous band which lies between and gives origin to the buccinator and superior constrictor muscles. It extends from the hamular process of the medial pterygoid plate to the posterior end of the mylo-hyoid ridge of the mandible (Fig. 91) and is easily felt from the mouth.

The upper margin of the superior constrictor is a free concave edge nd between it and the base of the skull there is a semilunar interval in which the muscular wall of the pharynx is deficient this interval is named the sinus of Morgagni. The wall of the sinus is *formed by the strengthened upper part of the* pharyngeal aponeurosis, which in this situation is sometimes named the pharyngo-basilar fascia and it is principally through it that the pharynx is att ched to the base of the skull. The pharyngeal aponeurosis lies between the muscle and mucous membrane layers of the pharyngeal wall, but below the sinus of Morgagni t gradually becomes weaker and ultimately disappears as a *distinct laye*

On the lateral part of the sinus of Morgagni under cover of the pharyngeal aponeurosis there re the upper part of two muscles of the soft palate the levator palati and the tensor palati (Fig. 91) The levator muscle lies deep and posterior to the tensor and in the interval

palate and through them the posterior ends of the middle and inferior conchæ on the lateral walls of the nasal cavities can be seen. The roof of the naso-pharynx is formed by the under surface of the fore part of the basi-occipital and the hind part of the basi-sphenoid, the bones being covered by a thick periosteum and the pharyngeal mucous membrane. The roof passes gradually into the posterior wall which lies in front of the lower part of the basi-occipital, the anterior arch of the atlas, and the body of the axis, these parts being covered by the pre-vertebral muscles and pre-vertebral fascia. On the upper part of the posterior wall and on the roof there is a prominence best marked in childhood, produced by a mass of lymphoid tissue in the mucous membrane it is known as the **naso-pharyngeal tonsil**, and over it the mucous membrane is wrinkled. The opening of a small median recess, named the pharyngeal bursa is usually to be found in its lower part it is just large enough to admit a fine probe. The naso-pharyngeal tonsil develops in the later months of fœtal life and continues to grow during infancy normally it begins to disappear about the sixth year Sometimes it greatly enlarges and, filling the naso-pharynx, prevents nasal breathing The lymph vessels from the tonsil drain into the upper deep cervical glands which lie below the tip of the mastoid process. It should be noted that the posterior wall and the roof of the naso-pharynx can be palpated by a finger introduced through the mouth. On each lateral wall, opposite the lower concha, there is the **pharyngeal orifice of the pharyngo-tympanic tube.** It is a vertical cleft bounded above and behind by a firm rounded prominence the **torus** or **cushion**, which is caused by the projecting end of the cartilage of the tube and often there is a collection of lymphoid tissue continuous with the naso-pharyngeal tonsil, in the mucous membrane round it. A vertical fold of mucous membrane the **salpingo-pharyngeal fold**, passes downwards from the lower part of the posterior border of the torus on the wall of the pharynx on which it gradually disappears it contains a slip of muscle, the salpingo-pharyngeus, which will be dissected later Behind the torus there is a deep recess on the lateral wall of the naso-pharynx it is named the **pharyngeal recess** or fossa of Rosenmüller

The **oral pharynx** lies below the soft palate and behind the mouth and the pharyngeal surface of the tongue which looks directly backwards into it and can now be closely examined owing to the mobility of the palate and the tongue the cavity varies considerably in size and form. It communicates with the mouth through the oro-pharyngeal isthmus, bounded by the palato-glossal arches. The posterior wall is in front of the third cervical vertebra. On the lateral walls there are the **palato-pharyngeal arches** which begin at the back part of the soft palate and are gradually lost as they are followed downwards. Within the folds are the **palato-pharyngeus muscles** by the contraction of which during swallowing they are brought nearly into contact, and, the uvula filling the interval between them, the opening into the naso-pharynx is obliterated the passage of food and

The naso-pharynx, the uppermost and widest part of the pharynx, lies behind the nasal cavities and above the soft palate, the sloping upper surface of which forms its floor It is an air cavity always patent and in swallowing it is shut off from the oral pharynx by the

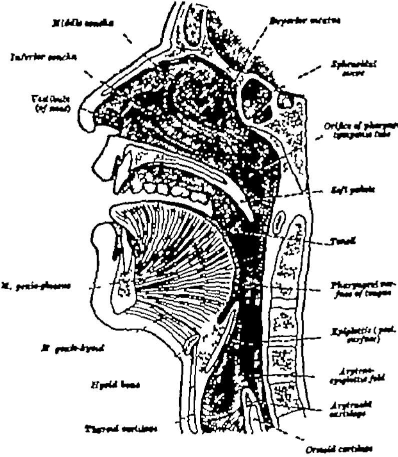


FIG. 92.
A diagram of median longitudinal section through the nose, the mouth, the pharynx, and the larynx.

soft palate being raised and brought into contact with the posterior wall. The posterior openings of the nasal cavities, the posterior nares or choanæ, are two oblong orifices, one and a quarter inches long and three-quarters of an inch wide separated from one another by the posterior edge of the septum nasi which is formed by the vomer they are bounded above by the base of the skull and below by the hard

posterior margin of the hard palate, at the sides it blends with the walls of the pharynx and its curved posterior border is continued into the palato-pharyngeal folds. The soft palate, 10 to 1? mm. in thickness, consists of a fold of mucous membrane between the two layers of which there are the muscles which act on it, an aponeurotic layer and a considerable amount of glandular and lymphoid tissue the glandular tissue makes up half the thickness of the palate.

The dissector is chiefly concerned with the exposure of the muscles. The definition of the individual muscles, however is difficult, and it is unlikely that their arrangement in definite layers, as shown in Fig 93 will be demonstrated. The mucous membrane which is thin must first be removed from both surfaces of the palate immediately deep to the layer on the under surface the thick layer of mucous glands will be exposed. The palato-glossal and palato-pharyngeal arches must then be stripped of their mucous membrane by which proceeding the **palato-glossus** and **palato-pharyngeus** muscles will be exposed. As far as possible these muscles should be followed to their attachments.

The **palato-glossus** is a small slip of muscle which, with the mucous membrane covering its surface, forms the palato-glossal fold. It arises in the under part of the soft palat where it is spread out immediately above the layer of the glands, being partly attached to the palatine aponeurosis and partly continuous with the muscle of the opposite side. It passes downwards, forwards, and laterally in front of the tonsil, and is inserted into the side of the back part of the tongue; a small bundle of it ends in the capsule of the tonsil.

The **palato-pharyngeus** muscle arises in the soft palate in two layers which enclose between them the levator palati and the uvular muscle (Fig 93). The upper layer is thin and is confined to the posterior part of the palate; it lies immediately under the mucous membrane and joins the opposit muscle in the middle line. The lower layer mu h thicker lies between th levator and tensor palati muscles, and is continuous with the opposite muscle across the middle line; it is attached to the palatal aponeurosis and the posterior margin of the hard palate. At the lateral edge of the palate the two layers com together and the muscle thus formed passes downwards behind the tonsil in the palato-pharyngeal f ld into the wall of the pharynx. There it spreads out int a thin sheet of fibres which blends with the expansion of the stylo-pharyngeus and with it ends partly on the posterior border of the thyroid cartilage and partly in the pharyngeal wall. The upper part of the muscle is joined by delicate muscular slip from the lower border of th medial margin of the cartilage of the pharyngo-tympanic tube near its orifice; this slip is named the **salpingo-pharyngeus** muscle (Fig 95)

The **musculus uvulae** consists of two delicate slips, one on each side of the middle line, which arise from the posterior nasal spine of the hard palate and descend into the uvula as they pass backwards they unite together int one. The muscle lies under the upper layer of the palato-pharyngeus and is easily ...ed if layer is removed.

... palati and tensor palati muscles were identified in the ... (p 250) and their superficial relations were studied

fluid from the oral pharynx into the naso-pharynx is thus prevented. In the triangular intervals bounded in front by the palato-glossal arches and behind by the palato-pharyngeal arches lie the tonsils (faucal tonsils) The dissection of these parts will be undertaken later

The **laryngeal pharynx** lies behind the entire length of the larynx. It diminishes rapidly in size and opposite the lower border of the cricoid cartilage, at the level of the sixth cervical vertebra, becomes continuous with the oesophagus. *In its anterior wall there are, from above downwards, the* **epiglottis**, a leaf-like cartilage the upper part of which is applied to the back of the tongue the **entrance of the larynx**, *the side boundaries of which are formed by the sharp* **aryteno-epiglottic folds** which stretch from the epiglottis in front to the

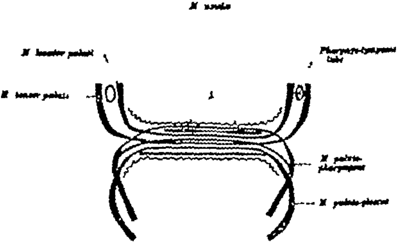


FIG. 91.

A diagram of the arrangement of the muscles of the soft palate. The mucous membrane is shown as red lines and immediately above the layer covering the lower surface is layer of palatal glands.

arytenoid cartilages behind and the posterior surface of the **cricoid cartilage** covered by the pharyngeal mucous membrane. The arytenoid cartilages, obscured at present by the mucous membrane which covers them, rest on the upper margin of the cricoid cartilage (Fig. 97). There is a forwardly directed recess of the pharynx named the **recessus piriformis**, *on each side of the lower part of the laryngeal opening* Its lateral wall is formed by the lamina of the thyroid cartilage and the thyro-hyoid membrane while medially it is bounded by the aryteno-epiglottic fold foreign bodies introduced into the pharynx are liable to be caught in it.

The **soft palate** is now to be dissected. *It is a movable curtain* which is raised during deglutition to assist in shutting off the naso-pharynx from the parts below It is attached in front to the

posterior margin of the hard palate at the sides it blends with the walls of the pharynx and its curved posterior border is continued into the palato-pharyngeal folds. The soft palate 10 to 12 mm. in thickness, consists of a fold of mucous membrane between the two layers of which there are the muscles which act on it an aponeurotic layer and a considerable amount of glandular and lymphoid tissue the glandular tissue makes up half the thickness of the palate.

The dissector is chiefly concerned with the exposure of the muscles. The definition of the individual muscles, however is difficult and it is unlikely that their arrangement in definite layers, as shown in Fig 93 will be demonstrated. The mucous membrane which is thin, must first be removed from both surfaces of the palate immediately deep to the layer on the under surface the thick layer of mucous glands will be exposed. The palato-glossal and palato-pharyngeal arches must then be stripped of their mucous membrane, by which proceeding the **palato-glossus** and **palato-pharyngeus** muscles will be exposed. As far as possible these muscles should be followed to their attachments.

The **palato-glossus** is a small slip of muscle which, with the mucous membrane covering its surface, forms the palato-glossal fold. It arises in the under part of the soft palate where it is spread out immediately above the layer of the glands, being partly attached to the palatine aponeurosis and partly continuous with the muscle of the opposite side. It passes downwards, forwards, and laterally in front of the tonsil, and is inserted into the side of the back part of the tongue; a small bundle of it ends in the capsule of the tonsil.

The **palato-pharyngeus** muscle arises in the soft palate in two layers which enclose between them the levator palati and the uvular muscle (Fig 93). The upper layer is thin and is confined to the posterior part of the palate it lies immediately under the mucous membrane and joins the opposite muscle in the middle line. The lower layer much thicker lies between the levator and tensor palati muscles, and is continuous with the opposite muscle across the middle line; it is attached to the palatal aponeurosis and the posterior margin of the hard palate. At the lateral edge of the palate the two layers come together and the muscle thus formed passes downwards behind the tonsil in the palato-pharyngeal fold into the wall of the pharynx There it spreads out into a thin sheet of fibres which blends with the expansion of the stylo-pharyngeus and with it ends partly on the posterior border of the thyroid cartilage and partly in the pharyngeal wall. The upper part of the muscle is joined by a delicate muscular slip from the lower border of the medial margin of the cartilage of the pharyngo-tympanic tube near its orifice this slip is named the **salpingo-pharyngeus muscle** (Fig 95).

The **musculus uvulæ** consists of two delicate slips, one on each side of the middle line, which arise from the posterior nasal spine of the hard palate and descend into the uvula; as they pass backwards they unite together int one. The muscle lies under the upper layer of the palato-pharyngeus and is easily defined if this layer is removed.

The **levator palati** and **tensor palati muscles** were identified in the sinus of Morgagni (p 250) and their superficial relations were studied

fluid from the oral pharynx into the naso-pharynx is thus prevented. In the triangular intervals bounded in front by the palato-glossal arches and behind by the palato-pharyngeal arches lie the **tonsils** (faucial tonsils). The dissection of these parts will be undertaken later.

The **laryngeal pharynx** lies behind the entire length of the larynx. It *diminishes rapidly in size and opposite the lower border of the* cricoid cartilage, at the level of the sixth cervical vertebra, becomes continuous with the œsophagus. In its anterior wall there are, from above downwards, the **epiglottis**, a *leaf-like* cartilage, the upper part of which is applied to the back of the tongue; the entrance of the larynx, the side boundaries of which are formed by the sharp **aryteno-epiglottic folds** which stretch from the epiglottis in front to the

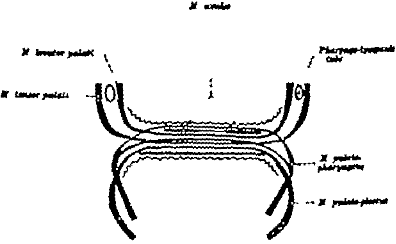


FIG. 93.

A diagram of the arrangement of the muscles of the soft palate. The mucous membrane is show ed lines and immediately bove the layer covering the lo er surface w la er of palatal glands.

arytenoid cartilages behind, and the posterior surface of the **cricoid cartilage** co ered by the pharyngeal mucous membrane. The arytenoid cartilages, hidden at present by the mucous membrane which covers them, rest on the uppe margin of the cricoid cartilage (Fig. 97). Th r is a forwardly directed recess f the pharynx, named the *recessus piriformis*, n ea h side of the lowe part of the laryngeal pening. It lat ral wall formed by the lamina of the thyroid cart lage and the thy hy d membrane while medially t bounded by the ryt n g gl tt fold foreign bodies introduced into the arynx re l l le t be caught in it.

The **soft palate** now t be dissected. It is a movable curtain which is raised luring deglut tion to assist in shutting off the naso-pharynx from the part bel w. It is ttached n front to the

The Action of the Muscles of the Pharynx and Soft Palate.—The muscles of the pharynx and the soft palate, acting with those of the tongue and the hyoid bone, are chiefly concerned in the act of swallowing In the first stage of this act the muscles of the floor of the mouth and the stylo-glossus and palato-glossus muscles press the tongue against the palate and so force the food backwards through the oro-pharyngeal isthmus. At the same time the hyoid bone is raised by the muscles attached to it from above, and the larynx is raised with it and by the action of the thyro-hyoid and stylo-pharyngeus muscles the raising of the larynx, as is described later is the main factor in closing the orifice of the larynx and protecting it against the entrance of food. The soft palat is simultaneously raised and made tense by the contraction of the levator and tensor palati muscles, and the palato-pharyngeal arches are brought together with the uvula between them, by the palato-pharyngeus muscles; the upper part of the superior constrictor also contracts and brings the posterior wall of the pharynx forwards into contact with them and the soft palate. The passage of food into the naso-pharynx is thus prevented and, the naso-pharynx being closed, respiration is inhibited. The soft palate forms a firm inclined surface on which food is carried into the lower part of the pharynx and into the grip of the constrictor muscles these muscles contract from above downwards and force the food along the pharynx into the oesophagus.

The tonsils are aggregations of the lymphoid tissue of the mucous membrane of the pharynx which are lodged in the tonsillar fossæ—the triangular intervals on the lateral walls of the oral pharynx above the back of the tongue and between the palato-glossal and palato-pharyngeal arches. They appear in the later months of foetal life and increase in size during childhood, and with the lingual and naso-pharyngeal tonsils complete a ring of lymphoid tissue round the entrance of the nose and mouth into the pharynx but after about six years of age they begin to atrophy and in the aged little of them may remain. They themselves therefore, cannot be satisfactorily studied in the dissecting room but their general relations are to be examined special preparations of them are in the museum.

The tonsils are masses of lymphoid tissue, with some mucous glands, in the mucous membrane, and when fully formed are almond-shaped they are then 20 to 25 mm. in length, about 15 mm. in width, and 10 mm in thickness. They lie in the tonsillar fossæ with their long axis nearly vertical. One surface faces int the pharynx and the other surface is embedded in the pharyngeal wall; the upper pole reaches, and may even burrow into, the soft palate and the lower pole rests on the tongue and is often continuous with the lymphoid tissue of the lingual tonsil and the anterior border is in contact with the palato-glossus muscle and the posterior border with the palato-pharyngeus muscle.

The lateral or deep surface is attached to and covered by a thin layer of fibrous tissue, called the capsule of the tonsil, which sends septa into its substance. It is fused with the pharyngeal poneurosis and is separated from the superior constrictor of the pharynx by a thin loose areolar tissue the tonsil can thus be pulled inwards with its capsule from the muscle. Lateral to the superior constrictor muscle there are (1) the stylo-pharyngeus and stylo-glossus muscles (2) the summit of the loop of the facial artery deep to the mandible and its ascending palatine branch; (3) the internal carotid artery

in the infra temporal region (p. 145) The mucous membrane of the pharynx must be removed as much as is necessary to follow these muscles from the base of the skull into the soft palate and in the interval between them the **cartilaginous part of the pharyngo-tympanic tube** is to be defined.

The **levator palati** is a thick rounded muscle which arises from the under surface of the apex of the petrous part of the temporal bone and from the lowe medial surface of the cartilage of the pharyngo-tympanic tube. It passes downwards, forwards, and medially across the upper border of the superior constrictor of the pharynx, and then below the orifice of the pharyngo-tympanic tube and enters the soft palate. There its fibres spread out between the uvular muscle above and the deep layer of the palato-pharyngeus muscle below (Fig. 93); most of them blend with the fibres of the opposite side but some of the anterior fibres are inserted into the palatal poneurosis.

The **tensor palati** is a flat band like muscle which is closely pplied to the deep surface of the internal pterygoid muscle; it is placed lateral to and in front of the levator palati (Fig 91). It arises from the scaphoid fossa at the base of the medial pterygoid plate, the posterior border of the under surface of the great wing of the sphenoid bone and its spinous process, and the lateral wall of the cartilage of the pharyngo-tympanic tube. The muscle descends along the lateral surface of the medial pterygoid plate and ends in a rounded tendon which wind round the hamulus and passes horizontally into the soft palate. Between the tendon and the hamulus there is a small bursa. In the palate the tendon spreads out above the palato-glossus fibres (Fig. 93), and is inserted into the palatal aponeurosis and the hind edge of the palate bone.

The **palatal aponeurosis** is a thin firm fibrous layer which is attached to the posterior margin of the hard palate. It supports the muscles and gives strength to the anterior part of the soft palat but when followed backwards becomes very thin and hard to define. *Laterally it is continuous with the pharyngeal aponeurosis.* The expansions of the tensor palati muscles form large part of its substance.

The chief **artery** of the soft palate is the **ascending palatine artery** a branch of the facial artery It ascends on the wall of the pharynx to the upper border of the superior constrictor and then descends on the lateral surface of the lowe part of the levator palati muscle into the palate The other vessels, the **palatine branch** of the ascending pharyngeal artery and the **descending palatine branch** of the internal maxillary rtery are a rule smaller and more difficult to dissect, though the latter may be seen under the mucous membrane of the lower surface. The **nerves** of the soft palate are not to be looked for Two branches enter t from the pheno-palatine (Meckel s) ganglion and are probably di tributed to the mucous membrane. The tensor palati muscle i upplied by a branch from the otic ganglion which rests on its surface (p 145) the fibres being derived from the mandibular nerve the palato-glossus s upplied by the hypoglossal nerve and the other muscles are supplied by th medullary part of the accessory nerve through the ph ryngeal branch of the vagus nerve and the pharyngeal plexus.

which is however about one inch behind the palato-pharyngeal arch; and (4) the internal pterygoid muscle and the mandible. The tonsil is thus deeply placed; it lies opposite a point half an inch above and in front of the angle of the jaw and cannot be palpated from the surface.

The medial free surface projects into the oral pharynx and can be seen when the mouth is opened and the tongue depressed. Its size is no indication of the total size of the tonsil but when the tonsil is enlarged its inward projection is greater and it may even meet its fellow in the middle line; in the healthy adult it does not project beyond the bounding arches. The surface is covered with thin closely adherent mucous membrane with stratified squamous epithelium, and on it there are the openings of the tonsillar crypts.

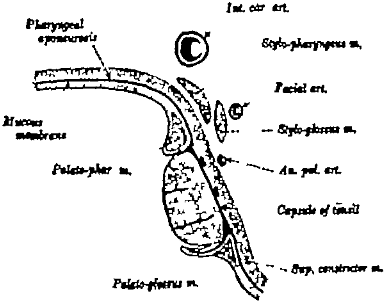


FIG. 94.

A diagram of horizontal section through the tonsil.

The crypts are tubular pits, twelve t twenty in number which extend int the tonsillar substance almost as far as the capsule; they are frequently enlarged and may contain purulent debris. There is a large developmental cleft, the intra-tonsillar cleft, in the upper part of the tonsil. The tonsillar tissue above it, which atrophies early and in the adult is usually absent, is covered by a fold of mucous membrane, the plica semilunaris, in bout 40 per cent. of subjects. The lower anterior part of the tonsil is similarly covered in the fœtus by a fold of mucous membrane the plica triangularis, which passes over the tonsil from the palato-glossal fold, the space between the plica and the surface of the tonsil being known as the tonsillar sinus; usually however the sinus is obliterated after birth by its walls becoming adherent and the front part of the tonsil is then embedded in the palato-glossal fold.

The tonsillar arteries are the tonsillar branch of the facial artery which is

the chief artery and branches from the palatine branch of the facial, the descending palatine branch of the maxillary the ascending pharyngeal, and the dorsales linguæ branches of the lingual artery; they perforate the superior constrictor muscle and the capsule of the tonsil to reach it The tonsillar veins form a plexus between the capsule and the superior constrictor; there are sometimes there too, some large veins from the soft palate which may give rise to troublesome hæmorrhage when the tonsil is removed. The tonsillar plexus drains into the pharyngeal plexus through the superior constrictor muscle. The lymph vessels from the tonsil pass through the superior constrictor and join the upper deep cervical glands, especially the jugulo-digastric or tonsillar gland (Fig 40) situated just behind and below the angle of the jaw

The cartilaginous part of the pharyngo-tympanic tube is now to be examined, its position and direction being defined by passing a probe into it through its pharyngeal opening and its wall exposed by cutting

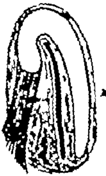


FIG 95.

A section through the pharyngo-tympanic tube. The tubal cartilage is to be coloured.

away the surrounding muscles It is lodged on the base of the skull in the groove between the petrous part of the temporal bone medially and the great wing of the sphenoid laterally and is directed from the pharynx postero-laterally with a slight inclination upwards. It passes first above and then on the lateral side of the levator palati muscle and afterwards lies between it and the tensor palati. The removal of the mucous membrane which covers the end of the tube will show that in its wall there is a plate of cartilage which is folded on itself and forms the upper and medial walls the cartilage is deficient below and laterally and the wall is there formed by dense fibrous tissue (Fig 95) The projecting end of the cartilage causes the elevation of the torus already described on the lateral wall of the naso-pharynx. The interior of the tube is lined with mucous membrane continuous with that of the pharynx and the tympanic cavity

There is a small muscular slip, the dilator tubæ, attached to the lateral margin of the cartilage of the tube (Fig. 93); it descends on the lateral side

of the tube and joins the tensor palati muscle. It assists in the dilation of the tube in swallowing to allow the passage of air along it to the tympanic cavity

The *intra-petrous part of the internal carotid artery is to be* examined at the present time on account of its relation to the pharyngo-tympanic tube. The artery traverses the bone in the carotid canal and is accompanied by the internal carotid sympathetic plexus and a number of small veins. The carotid canal is to be opened from *below with the bone forceps. The part of the artery contained in it* is about three-quarters of an inch long At first it ascends vertically and then, bending suddenly, it runs horizontally forwards and medially and emerges from the canal at the apex of the petrous bone. It then crosses the foramen lacerum and turning upwards pierces the periosteal layer of the dura mater and enters the *cavernous sinus* where it was previously examined (Fig. 64). In the carotid canal it lies below and in front of the tympanic cavity and the cochlea, from the former of which it is separated by a thin plate of bone (Fig. 80) and it is postero-medial to the pharyngo-tympanic tube and below the semilunar ganglion. The internal carotid sympathetic plexus, which accompanies the *artery is the continuation of the internal carotid nerve* which proceeds from the upper end of the superior cervical sympathetic ganglion (p. 158) It is continued along the artery through the cavernous sinus and on its terminal cerebral branches, but its dissection is hardly to be attempted by the student (p. 185).

THE LARYNX

The larynx is the upper expanded part of the windpipe and is specially modified for the production of the voice. It lies in the upper part of the front of the neck below the hyoid bone and is directly continued *into the trachea below Posteriorly it is related to the* pharynx into which its orifice opens, anteriorly it is covered by the skin, the fasciæ, and the infra hyoid muscles, and at the sides the lateral lobes of the thyroid gland rest on it and it is related to the great vessels of the neck. Its position alters with movements of the head and during deglutition, but it may be considered to lie opposite the fourth, fifth, *and sixth cervical vertebræ in the male* and a little *higher* in the female and in children. *It is characteristically* much larger in the male than in the female at the time of puberty its rapid increase in size is a feature of male development.

The walls of the larynx are formed *by the* laryngeal cartilages (Fig 96) which articulate with one another and are connected together by ligaments. They are moved on one another by the laryngeal muscles, the *movements* being such as to alter the position and tension of the vocal folds, *two ligamentous f lds which cross the interior of the* larynx from the front to the back they are made to vibrate by the passing air and produce the voice. The cavity of the larynx is lined with mucous membrane.

The larynx is to be placed on a block with the anterior surface upwards and fixed in that position with pins. The external laryngeal nerve is to be traced to the crico-thyroid muscle and the internal and recurrent (inferior) laryngeal nerves and their accompanying vessels the superior and inferior laryngeal arteries, are to be secured (Fig 91) The dissector should then clear away entirely the omo-hyoid sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles, and the fibres of origin of the inferior constrictor muscle of the pharynx are to be removed from the thyroid and cricoid cartilages. The thyro-hyoid membrane, the crico-thyroid muscles, and part of the crico-thyroid membrane are now exposed their attachments are to be defined and they are to be examined (Fig 96)

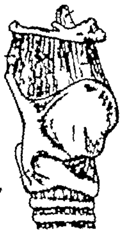


Fig. 96.

The cartilages and ligaments of the larynx viewed from the side. The oblique line of the thyroid cartilage is to be named.

The thyro-hyoid membrane (Fig. 96) is a broad sheet which fills the interval between the thyroid cartilage and the hyoid bone. It consists of a thick central part (the median thyro-hyoid ligament), rounded cord like marginal parts (the lateral thyro-hyoid ligaments), and thin membranous parts in the intervals between the median and lateral parts. The central part is largely composed of elastic fibres. It is attached above to the deep surface of the upper margin of the hyoid bone and below to the sides of the deep median notch in the upper margin of the thyroid cartilage The upper part of its anterior surface, therefore, lies behind the body of the hyoid bone, a bursa being interposed ; in forward movements of the head and in swallowing the upper border of the thyroid cartilage is thus allowed to slip upwards behind the hyoid bone The thin membranous parts are attached below to the upper border of the lamina of the thyroid cartilage and above to the deep surface of the upper margin of the great cornua of the hyoid bone They are pierced by the internal laryngeal nerve and the superior laryngeal artery on each side. The marginal cord-like parts of the membrane extend from

of the tube and joins the tensor palati muscle. It assists in the dilation of the tube in swallowing to allow the passage of air along it to the tympanic cavity

The intra-petrous part of the internal carotid artery is to be examined at the present time on account of its relation to the pharyngo-tympanic tube. The artery traverses the bone in the carotid canal and is accompanied by the internal carotid sympathetic plexus and a number of small veins. The carotid canal is to be opened from below with the bone forceps. The part of the artery contained in it is about three-quarters of an inch long At first it ascends vertically and then, bending suddenly it runs horizontally forwards and medially and emerges from the canal at the apex of the petrous bone. It then crosses the foramen lacerum and turning upwards pierces the periosteal layer of the dura mater and enters the cavernous sinus where it was previously examined (Fig 64) In the carotid canal it lies below and in front of the tympanic cavity and the cochlea, from the former of which it is separated by a thin plate of bone (Fig 80) and it is postero-medial to the pharyngo-tympanic tube and below the semilunar ganglion. The internal carotid sympathetic plexus, which accompanies the artery is the continuation of the internal carotid nerve which proceeds from the upper end of the superior cervical sympathetic ganglion (p. 158) It is continued along the artery through the cavernous sinus and on its terminal cerebral branches, but its dissection is hardly to be attempted by the student (p. 185).

THE LARYNX

The larynx is the upper expanded part of the windpipe and is specially modified for the production of the voice. It lies in the upper part of the front of the neck below the hyoid bone and is directly continued into the trachea below Posteriorly it is related to the pharynx into which its orifice opens, anteriorly it is covered by the skin, the fasciæ, and the infra hyoid muscles, and at the sides the lateral lobes of the thyroid gland rest on it and it is related to the great vessels of the neck. Its position alters with movements of the head and during deglutition but it may be considered to lie opposite the fourth, fifth, and sixth cervical vertebræ in the male and a little higher in the female and in children. It is characteristically much larger in the male than in the female at the time of puberty its rapid increase in size is a feature of male development.

The walls of the larynx are formed by the laryngeal cartilages (Fig. 96) which articulate with one another and are connected together by ligaments. They are moved on one another by the laryngeal muscles, the mo ements being such as t alter the position and tension of the vocal folds, two ligamentous folds which cross the interior of the larynx from the front to the back they are made to vibrate by the passing air and produce the voice. The cavity of the larynx is lined with mucous membrane.

The larynx is to be placed on a block with the anterior surface upwards and fixed in that position with pins. The **external laryngeal nerve** is to be traced to the **crico-thyroid muscle** and the **internal and recurrent (inferior) laryngeal nerves** and their accompanying vessels the **superior and inferior laryngeal arteries**, are to be secured (Fig 91). The dissector should then clear away entirely the omo-hyoid, sterno-hyoid, sterno-thyroid, and thyro-hyoid muscles and the fibres of origin of the inferior constrictor muscle of the pharynx are to be removed from the **thyroid and cricoid cartilages**. The **thyro-hyoid membrane**, the **crico-thyroid muscles**, and part of the **crico-thyroid membrane** are now exposed their attachments are to be defined and they are to be examined (Fig 96).

FIG 96.

The cartilages and ligaments of the larynx viewed from the side The oblique line of the thyroid cartilage is to be named.

The **thyro-hyoid membrane** (Fig 96) is a broad sheet which fills the interval between the thyroid cartilage and the hyoid bone. It consists of a thick central part (the median thyro-hyoid ligament), rounded cord-like marginal parts (the lateral thyro-hyoid ligaments), and thin membranous parts in the intervals between the median and lateral parts. The central part is largely composed of elastic fibres. It is attached above to the deep surface of the upper margin of the hyoid bone and below to the sides of the deep median notch in the upper margin of the thyroid cartilage. The upper part of its anterior surface therefore, lies behind the body of the hyoid bone, a bursa being interposed; in forward movements of the head and in swallowing the upper border of the thyroid cartilage is thus allowed to slip upwards behind the hyoid bone The thin membranous parts are attached below to the upper border of the lamina of the thyroid cartilage and above to the deep surface of the upper margin of the great cornua of the hyoid bone. They are pierced by the internal laryngeal nerve and the superior laryngeal artery on each side. The marginal cord-like parts of the membrane extend from

of the tube and joins the tensor palati muscle. It assists in the dilation of the tube in swallowing to allow the passage of air along it to the tympanic cavity

The intra-petrous part of the internal carotid artery is to be examined at the present time on account of its relation to the pharyngo-tympanic tube. The artery traverses the bone in the carotid canal and is accompanied by the internal carotid sympathetic plexus and a number of small veins. The carotid canal is to be opened from below with the bone forceps The part of the artery contained in it is about three-quarters of an inch long. At first it ascends vertically and then, bending suddenly it runs horizontally forwards and medially and emerges from the canal at the apex of the petrous bone. It then crosses the foramen lacerum and turning upwards pierces the periosteal layer of the dura mater and enters the cavernous sinus where it was previously examined (Fig. 64). In the carotid canal it lies below and in front of the tympanic cavity and the cochlea from the former of which it is separated by a thin plate of bone (Fig. 80) and it is postero-medial to the pharyngo-tympanic tube and below the semilunar ganglion. The internal carotid sympathetic plexus, which accompanies the artery is the continuation of the internal carotid nerve which proceeds from the upper end of the superior cervical sympathetic ganglion (p. 158) It is continued along the artery through the cavernous sinus and on its terminal cerebral branches, but its dissection is hardly to be attempted by the student (p. 165).

THE LARYNX

The larynx is the upper expanded part of the windpipe and is specially modified for the production of the voice. It lies in the upper part of the front of the neck below the hyoid bone and is directly continued into the trachea below Posteriorly it is related to the pharynx into which its orifice opens, anteriorly it is covered by the skin, the fasciæ, and the infra hyoid muscles, and at the sides the lateral lobes of the thyroid gland rest on it and it is related to the great vessels of the neck. Its position alters with movements of the head and during deglutition, but it may be considered to be opposite the fourth, fifth, and sixth cervical vertebræ in the male and a little higher in the female and in children. It is characteristically much larger in the male than in the female at the time of puberty its rapid increase in size is a feature of male development.

The walls of the larynx are formed by the laryngeal cartilages (Fig 96) which articulate with one another and are connected together by ligaments. They are moved on one another by the laryngeal muscles, the movements being such as to alter the position and tension of the vocal folds, two ligamentous folds which cross the interior of the larynx from the front to the back they are made to vibrate by the passing air and produce the voice. The cavity of the larynx is lined with mucous membrane.

the ends of the superior cornua of the thyroid cartilage to the tips of the great cornua of the hyoid bone; a small oval cartilaginous or calcified nodule, the cartilago triticea, is usually developed in each of them (Fig 96)

The crico-thyroid muscle (Fig 91), triangular in form, arises from the front and lateral part of the cricoid cartilage. Its fibres diverge as they pass backwards and upwards, and as a rule are separated into two groups at their insertion; the posterior fibres are inserted into the inferior cornu of the thyroid cartilage and the anterior fibres are attached to the lower border of the posterior part of its lamina. The insertion of the posterior fibres is overlaid by a tendinous arch which gives origin to the *inferior constrictor* muscle of the pharynx. The crico-thyroid muscle is supplied by the external laryngeal nerve.

The crico-thyroid muscles are to be cut away to expose the crico-thyroid membrane.

The crico-thyroid membrane, a highly elastic membrane, is divisible into a median and two lateral parts. The median part, broad below and narrow above, extends from the upper border of the anterior arch of the cricoid cartilage t the middle part of the lower border of the thyroid cartilage. Each lateral part of the membrane is attached below along the inner edge of the upper border of the cricoid cartilage and extends upwards on the medial side of the lamina of the thyroid cartilage (Fig 96) so that a seeker may be pushed upwards for a short distance between the two structures. It ends above in a free thickened border which lies in the substance of the vocal fold and is attached behind to the vocal process of the arytenoid cartilage and in front to the angle of union between the two laminæ of the thyroid cartilage (Fig 100). Its deep surface is covered by the mucous membrane of the larynx (Fig 99).

The thyroid cartilage, the largest of the laryngeal cartilages, is now fully exposed from the front and can be examined (Fig. 96). It consists of two flat plates, named the laminæ, which are widely separated behind but are joined together in the middle line in front. The laminæ are fused, however only in their lower parts above they are separated by a deep V-shaped notch the thyroid notch. In the adult female the laminæ meet at an angle of about 120° but in the male they meet at an angle of 90° and form a projection, most prominent at its upper part which has been named the pomum Adami. The posterior border of each lamina is thickened and gives attachment to the stylo-pharyngeus and palato-pharyngeus muscles. It is prolonged upwards and downwards in tw slender processes or cornua (Fig. 96). The superior cornu is connected t the tip of the great cornu of the hyoid bone by the lateral part of the thyro-hyoid membrane while the inferior cornu thicker and shorter articulates with the side of the cricoid cartilage. The outer surface of the lamina is relatively flat. It is crossed from above downwards and slightly forwards by an oblique line or ridge at each end of which there is a prominence the superior and the inferior tubercle. The line gives attachment above and below to the thyro-hyoid and sterno-thyroid muscles, while the inferior constrictor muscle of the pharynx arises from the smooth

the dissector will readily recognise the **posterior crico-arytenoid muscles** (Fig. 97) The tendinous band through which the longitudinal fibres of the œsophagus are fixed to the posterior surface of the cricoid cartilage is also to be defined it is attached between the posterior crico-arytenoid muscles to the prominent median ridge on the cartilage On the posterior surface of the arytenoid cartilages and stretching across the interval between them, the **arytenoid muscle** should be defined. It consists of deep transverse fibres and superficial oblique fibres the latter fibres decussate across the middle line and are continued into the aryteno-epiglottic folds (Fig 97) The mucous membrane is then to be removed from the aryteno-epiglottic folds. If this is done with care there will be exposed within each fold the **aryteno-epiglottic muscle**, small in size and formed of pale fibres and the **corniculate and cuneiform cartilages**. The muscles which are now exposed are to be examined.

The **posterior crico-arytenoid muscle** (Fig 97) arises from the shallow depression on the lateral part of the broad posterior surface of the cricoid cartilage, the muscles of the two sides being separated by the prominent median ridge. The fibres of the muscle are directed upwards and laterally and converge to be inserted into the muscular process which projects laterally from the base of the arytenoid cartilage (Fig 100).

The **arytenoid muscle** (Fig 97) consists of two parts, a transverse part and an oblique part. The oblique part is placed superficial to the transverse part. It consists of two bundles of fibres which cross each other like the limbs of the letter X Each bundle arises from the back of the muscular process of one arytenoid cartilage and passes to the apex of the opposite cartilage; some of its fibres are inserted there but most of them are continued round the lateral margin of the cartilage and are prolonged in the aryteno-epiglottic fold t the epiglottis as the aryteno-epiglottic muscle. The transverse part of the arytenoid muscle is a thin flat band of fibres which bridge the interval between the arytenoid cartilages they are attached to the lateral parts of the posterior surfaces of the cartilages.

The remaining laryngeal muscles are to be dissected only on one side On that side the lateral part of the thyro-hyoid membrane is to be divided and the inferior horn of the thyroid cartilage disarticulated from the side of the cricoid cartilage The lamina of the thyroid cartilage must now be divided a little distance short of the middle line and the detached piece of cartilage carefully removed. In old subjects, and especially in men, it will be noted that the cartilage is partly calcified. Two muscles are now exposed, namely the **lateral crico-arytenoid muscle** below and the **thyro-arytenoid muscle**, a broad sheet of fibres, above. They are to be cleaned and as far as possible their attachments are to be defined and while this is being done branches of the **recurrent laryngeal nerve** are to be traced to them. The trunk of the nerve has already been secured (Fig 91) It is now to be followed upwards on the lateral surface of the cricoid cartilage immediately behind the crico-thyroid articulation. About the level of

corniculate cartilage. These nodules give rise to two small rounded eminences in the posterior part of the fold and are easily seen when the larynx is examined in the living subject they should be felt between the finger and thumb in the specimen, but often it is not easy to distinguish the cuneiform cartilage.

The **cavity of the larynx** is to be looked into from above. It is much smaller than would be expected from an examination of the exterior Crossing the cavity antero-posteriorly there are two shelf like folds of mucous membrane projecting inwards from each side the upper

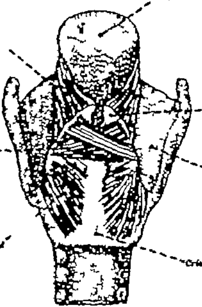


FIG. 97

The cartilages and muscles of the larynx from behind. The muscular processes of the arytenoid cartilages are to be named and the muscles are to be coloured.

folds, more widely separated than the lower are the **vestibular folds** (false vocal cords) while the lower pair are the **vocal folds** (true vocal cords) (Fig 99). The latter folds re the chief agents in the production of the voice and, as lready stated they are changed in position and their tension is altered by the action of the laryngeal muscles and the elasticity of the laryngeal ligaments

The pharyngeal mucous membrane which covers the posterior surface of the cricoid nd aryt noid cartilages is now to be removed, care being taken to preserve the recurrent **laryngeal nerves** and the **inferior laryngeal arteries** which pass upwards between the cricoid and thyroid cartilages. On the posterior surface of the cricoid cartilage

The cavity of the larynx is to be opened by dividing the cricoid cartilage in the middle line the incision is to be continued in the middle line of the trachea The two halves of the larynx are to be separated and the interior of the **cavity of the larynx** examined. It is subdivided into three parts the upper part, the **vestibule**, lies above the vestibular folds the intermediate part is the interval between the vestibular folds and the vocal folds and the lower part lies below the vocal folds and is continued into the tra hea (Fig 98) The walls of these parts are to be examined on the side on which the muscles are intact.

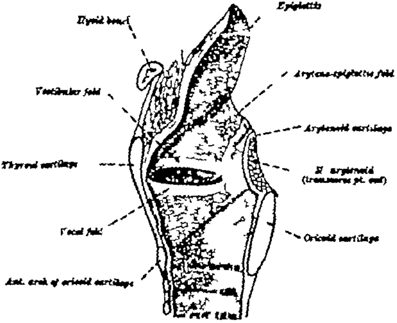


FIG. 98.

The side wall of the cavity of the larynx. The laryngeal cartilages and the thyro-hyoid membrane are to be coloured.

The vestibule diminishes in width from above downwards and, owing to the obliquity of the entrance to the larynx, its anterior wall is longer than its posterior wall (Fig 98) The anterior wall is formed by the posterior surface of the epiglottis and the thyro-epiglottic ligament, both being covered with mucous membrane The lateral wall is formed by the medial surface of the aryteno epiglottic fold. It is for the most part smooth and slightly concave but in its posterior part there are two vertical elevations, one posterior to the other separated by a shallow groove (Fig. 98). The anterior elev tion is formed by the cuneiform cartilage and a mass of mucous glands beside it, while the posterior elevation is formed by the anterior margin of the ary tenoid cartilage and the corniculate cartilage above it The posterior wall of the estibule is narrow and corresponds to the interval between the arytenoid cartilages.

the articulation it divides into two branches, the anterior of which supplies the lateral crico-arytenoid and thyro-arytenoid muscles, while the posterior branch passes through and supplies the posterior crico-arytenoid and then enters the arytenoid muscle. The recurrent nerve, therefore supplies all the muscles of the larynx with the exception of the crico-thyroid muscle which is supplied by the external laryngeal nerve the fibres to the laryngeal muscles come from the medullary part of the accessory nerve.

The lateral crico-arytenoid muscle is smaller than the posterior muscle. It is triangular in form. It arises from the upper border of the lateral part of the cricoid cartilage, and passing obliquely upwards and backwards, its fibres converge and are inserted into the front of the muscular process of the arytenoid cartilage.

The thyro-arytenoid muscle is a broad thin sheet of muscle fibre which lies superficial to the vocal fold and ventricle of the larynx and is covered by the lamina of the thyroid cartilage. It arises in front from the angle of union of the two laminae of the thyroid cartilage and the median part of the crico-thyroid membrane and passes backwards to be inserted into the base and lateral surface of the arytenoid cartilage. Several parts have been distinguished in the muscle. Thus: (1) From the upper part of the sheet a number of fibres pass into the aryteno-epiglottic fold and are continued to the side of the epiglottis; they are named the thyro-epiglottic muscle. (2) A few fibres extend along the wall of the ventricle of the larynx and are known as the ventricularis muscle. (3) The lower and deeper fibres form a band, triangular on transverse section, which is named the vocalis muscle (Fig. 90). It runs parallel with the vocal fold and some of its fibres are attached to the ligament of the fold; most of them, however are attached to the lateral surface of the vocal process of the arytenoid cartilage (Fig. 100).

The recurrent laryngeal nerve arises from the vagus nerve, differently on the two sides of the body (p. 109). It has already been followed upwards in the neck in the groove bet een the oesophagus and the trachea to the point at which it disappears under the lower border of the inferior constrictor muscle of the pharynx (Fig 91). It then ascends on the lateral side of the cricoid cartilage and, as already described, breaks into two branches which supply all the muscles of the larynx except the crico-thyroid muscle. It is, therefore, the motor nerve to the larynx, the motor fibres being derived from the medullary part of the accessory nerve. It also contains some sensory fibres which are distributed to the mucous membrane of the larynx below the vocal folds and the mucous membrane of the lower part of the pharynx and the upper part of the oesophagus. Its posterior branch is connected to the internal laryngeal nerve by a slender twig, the ramus anastomaticus.

The lateral crico-arytenoid muscle is to be removed and the fibres of the thyro-arytenoid muscle picked away in order to demonstrate the relation of the vocalis muscle to the vocal ligament. The vocalis may then be removed. The outer surface of the lateral part of the crico-thyroid membrane will now be e posed and it will be seen to be continued into the vocal f ld, of which, by its thickened free border it forms the vocal ligament (Fig 99).

The cavity of the larynx is to be opened by dividing the cricoid cartilage in the middle line the incision is to be continued in the middle line of the trachea The two halves of the larynx are to be separated and the interior of the cavity of the larynx examined. It is subdivided into three parts the upper part the vestibule, lies above the vestibular folds the intermediate part is the interval between the vestibular folds and the vocal folds and the lower part lies below the vocal folds and is continued into the trachea (Fig. 98) The walls of these parts are to be examined on the side on which the muscles are intact.

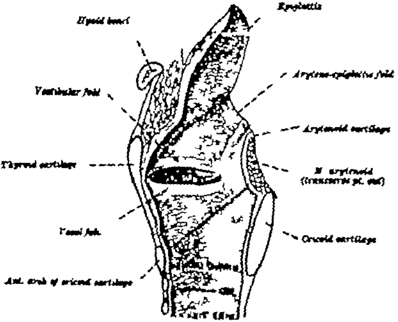


Fig. 98.

The side wall of the cavity f the larynx. The laryngeal cartilages and the thyro-hyoid membrane are to be coloured.

The vestibule diminishes in width from above downwards and, owing to the obliquity of the entrance to the larynx, its anterior wall is longer th[illegible] its posterior wall (Fig. 98). The anterior wall is formed by [illegible] surface of the epiglottis and the thyro-epiglottic ligament bo[illegible] with mucous membrane The lateral wall is formed by [illegible]gin of of the aryteno-epiglottic fold It is for the most part [illegible] concave but in its posterior part there are two vertic[illegible]ween the posterior to the other separated by a shallow groove (Fig. [illegible] lev tion is formed by the cuneiform cartilage and a ma[illegible] beside it while the posterior elevation is formed by the [illegible] the arytenoid cartilage and the corniculate cartilage above it[illegible] wall of the estibule is narrow and corresponds to the interval [illegible] arytenoid cartilages.

The intermediate part of the laryngeal cavity bounded above by the vestibular folds and below by the vocal folds, is the smallest of the three parts of the cavity Opening into it, on each side, by a narrow elliptical orifice is a recess named the sinus or ventricle of the larynx, the extent of which should be explored with a seeker It passes upwards undermining the ventricular fold (Fig 90). A narrow diverticulum, the appendix of the ventricle, arises from its anterior part; it ascends between the ventricular fold and the lamina of the thyroid cartilage as a rule as far as the upper border of the cartilage. The mucous membrane of the ventricle and its appendix is rich in mucous glands, the secretion of which is poured down on the vocal fold and lubricates its surface.

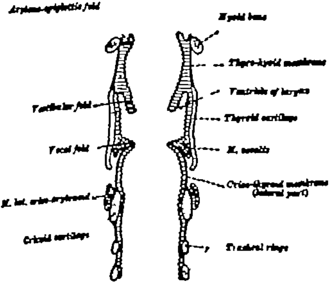


FIG. 90.

A diagram of the larynx in vertical section. The laryngeal cartilages are to be coloured.

The lowest part of the aryngeal cavity leads directly into the trachea
90). It is narrow from side to side above but gradually widens below
ular like the trachea. It is bounded in front and
lowest p ace of the crico-thyroid membrane, and behind
ides by oid cartilage. A seeker is to be pushed through
ner m the front and it is to be noted that it enters
thyro ds; it is through the membrane that an
bel geal [illegible]ruction.

the posterior surface of the epiglottis and still more over the vocal folds the membrane is very thin and firmly bound to the underlying tissues, the submucous tissue being practically absent over the other parts, however the submucous tissue is abundant and the membrane can easily be separated. The submucous tissue is particularly abundant and loose in and near the aryteno-epiglottic folds, and in disease is liable to infiltration with fluid sufficient to occlude the entrance to the larynx. Except over the vocal folds the mucous membrane is *provided with numerous* mucous glands which secrete an abundant mucus; they abound particularly in the ventricles of the larynx and on the epiglottis where they occupy pits in the cartilage.

The **vestibular folds** or **false vocal cords** are soft flaccid folds of mucous membrane, the interval between which the rima vestibuli is

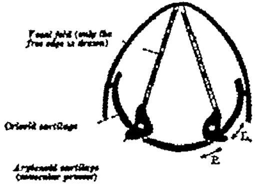


FIG. 100

A diagram of the attachments of the vocal folds and the boundaries of the widely open rima glottidis. The arytenoid cartilages move round vertical axes, represented by white dots, so that their vocal processes which project forwards may be approximated to or separated from one another P shows the direction of the pull of the posterior crico-arytenoid muscle on the muscular process; it would, therefore, separate the vocal fold from its fellow L shows the pull of the lateral crico-arytenoid muscle which would approximate one fold to the other

considerably wider than that between the vocal folds when the larynx is examined from above therefore the four folds can be seen. Each vestibular fold contains a few muscle fibres numerous mucous glands, and a narrow indefinite band of fibro-elastic tissue named the vestibular ligament it is attached to the thyroid cartilage in front and the arytenoid cartilage behind.

The **vocal folds** or **true vocal cords** are the means by which the voice is produced, the vestibular folds being of little importance in this respect. They are almost white in colour the *mucous membrane* covering them being thin and firmly adherent to the **vocal ligaments** which lie in them. They extend from the angle between the laminæ of the thyroid cartilage in front to the vocal **processes** of the arytenoid cartilages behind (Fig. 100) each fold being triangular in shape on transverse section the medial free edge is thin and sharp (Fig. 99)

The interval between the folds is named the rima glottidis It is continued backwards for about a quarter of an inch between the vocal processes of the arytenoid cartilages. The length of the entire opening is about an inch (23 mm.) in the adult male and about three-quarters of an inch (17 mm.) in the female and in the male before puberty The form of the opening is altered by the arytenoid cartilages being turned round their vertical axes and their vocal processes, carrying the vocal folds, being made to approach or separate from one another. The opening can thus be reduced to a mere chink as in singing a high note but when opened as widely as possible it becomes a lozenge-shaped space (Fig 100) in ordinary respiration it is intermediate between these forms.

The vocal ligament, which lies within the vocal cord, has already been described to be the upper free border of the lateral part of the crico-thyroid membrane (Fig. 99). It consists of a band of yellow elastic tissue, and is attached in front to the angle of the thyroid cartilage and behind to the vocal process which projects forwards from the base of the arytenoid cartilage (Fig 100). The vocalis muscle (p. 266) lies lateral to and parallel with it, and it is covered by mucous membrane which is thin and firmly bound to it.

The internal laryngeal nerve and the superior laryngeal artery are now to be followed through the thin lateral part of the thyro-hyoid membrane and then along the lateral wall of the sinus piriformis of the pharynx to the larynx. The nerve should be made taut and fixed, and then the mucous membrane which covers it should be removed In this way the nerve can easily be discovered and its branches traced to the walls of the larynx of which it is the sensory nerve.

The internal laryngeal nerve is the larger division of the superior laryngeal branch of the vagus nerve (p. 99) It is a sensory nerve and its branches are distributed chiefly to the mucous membrane of the larynx. It pierces the lateral part of the thyro-hyoid membrane in company with the superior laryngeal artery and then divides int a number of branches. The uppermost branches are distributed to the aryteno-epiglottic fold, the epiglottis and the base of the tongue and the three folds between them. The intermediat branches supply the side wall of the larynx as far down as the vocal folds, while the lowest branches supply the pharyngeal mucous membrane over the posterior surface of the arytenoid and cricoid cartilages, and one of them, a slender twig, joins the posterior branch of the recurrent laryngeal nerve and is distributed through it to the mucous membrane of the lower part of the pharynx and the upper part of the oesophagus

The superior and inferior laryngeal arteries are distributed in company with their companion nerves, and supply the mucous membrane, the glands, and the muscles of the laryngeal wall.

The remaining part of th thyroid cartilage is to be removed from the cricoid cartilage by di iding th fibrous capsule which surrounds the crico-thyroid joint. The crico-thyroid joints are diarthrodial

joints. The movements which take place at them are of two kinds gliding and rotatory The rotatory movement is one in which the cricoid cartilage rotates round a transverse axis which passes through the two joints and the gliding movement is a backward and forward movement of the cricoid cartilage on the thyroid cartilage both movements are produced by the **crico-thyroid muscles**. These muscles acting from a fixed thyroid cartilage pull the upper border of the anterior part of the cricoid cartilage upwards (rotatory movement) and backwards (gliding movement) and thus increase the distance between the angle of the thyroid cartilage and the vocal processes of the arytenoid cartilages which surmount and follow the downward and backward movement of the upper border of the posterior part of the cricoid cartilage. The vocal folds are thus made tense by the contraction of the crico-thyroid muscles Relaxation of the folds is brought about by the elasticity of their ligaments and probably they may be further relaxed by the contraction of the **vocales muscles**, parts of the thyro-arytenoid muscles.

The **cricoid** and the **arytenoid cartilages** are to be cleaned by removing the muscle fibres attached to them and the mucous membrane with which they are covered. While this is being done the two **cuneiform cartilages**, small rod-shaped nodules of yellow elastic cartilage should be sought near the posterior ends of the aryteno-epiglottic folds often however they will not be found. The two pyramidal **corniculate cartilages** should also be looked for they are placed on the summits of the arytenoid cartilages within the aryteno-epiglottic folds.

The **cricoid cartilage**, thicker and stronger than the thyroid cartilage but like it undergoing calcification with ge, is shaped like a signet ring. The broad posterior part, the lamina, is quadrilateral, measuring in the male about an inch from above downwards. Its posterior surface is divided by a median ridge into two shallow concave areas which giv origin to the posterior crico-arytenoid muscles; to the ridge itself the longitudinal fibres of the oesophagus are attached by a strong tendinous band. On the upper border of the lamina there is an oval facet on each side of the middle line for articulation with the base of the arytenoid cartilage. The anterior part of the cartilage, the arch, is narrow in front, but its upper border rapidly ascends to the lamina the lower border is horizontal. The arch is connected t the first ring of the trachea below by the crico-tracheal membrane, while the crico-thyroid membrane is attached to its upper border On each side of the back part of the arch there is a small round facet for articulation with the inferior cornu of the thyroid cartilage (Fig 96)

The **arytenoid cartilages**, which are to be left in position during the examination, are pyramidal in form and about 20 mm. high. The apices are directed upwards and curved backwards, while the bases articulate with the upper border of the lamina of the cricoid cartilage. Of the three surfaces of each cartilage one looks medially towards the corresponding surface of the opposite cartilage; one looks posteriorly and gi es attachment to the transverse part of the arytenoid muscle; while the third, the largest surface,

faces antero-laterally and gives attachment to the thyro-arytenoid muscle and, above it to the vestibular fold. These surfaces are separated by well-defined borders. At the base of the cartilage the lateral border is prolonged laterally and backwards as a short prominent process, named the muscular process, to which the posterior and lateral crico-arytenoid muscles are attached, while the anterior border is prolonged forwards as the vocal process and gives attachment to the vocal fold (Fig 100).

The crico-arytenoid joints are diarthroses. The movements which take place at them, as the dissector can readily demonstrate for himself are of two kinds (1) A gliding movement, by which the arytenoid cartilages are bodily carried medially and laterally the arytenoid muscle draws the cartilages together and thus the width of the back part of the rima glottidis is lessened. (2) A rotatory movement, in which the arytenoid cartilages revolve round vertical axes. By this movement the vocal processes are swung medially and laterally so that the front part of the rima glottidis is closed or opened. The posterior crico-arytenoid muscles, by drawing the muscular processes of the cartilages backwards and medially swing the vocal processes laterally the vocal folds are thus abducted and the rima glottidis is opened. The lateral crico-arytenoid muscles act in the opposite direction by drawing the muscular processes forwards they adduct the vocal folds and close the rima glottidis (Fig. 100)

The muscles of the larynx also act during deglutition, for in that act the aperture of the larynx is closed by the arytenoid cartilages being drawn together and carried forwards so that their upper ends are in close contact with the cushion of the epiglottis. The muscles chiefly concerned in these movements are the arytenoid, thyro-arytenoid, and aryteno-epiglottic muscles which together may well be regarded as a sphincter of the laryngeal orifice by their action they convert it into a tri-radiate (T-shaped) slit. At the same time the larynx is raised through its ligamentous connexion to the hyoid bone and by the action of the thyro-hyoid, stylo-pharyngeus, and palato-pharyngeus muscles, and the closed laryngeal orifice is firmly pressed against the epiglottis.

The student should now make cardboard models of the cartilages of the larynx and articulate them together In this way he can easily learn the action of the laryngeal muscles.

THE NASAL CAVITIES

The parts of the mandible which still remain, together with the tongue and the larynx, are to be cut away from the upper part of the specimen, and n it the nasal cavities are to be dissected. The skull must be divided into two lateral parts by sawing vertically through it close to one side of the nasal septum. As a general rule the nasal septum is not wholly in the median plane but deviates a little and is convex to one or other side, more frequently to the right. The direction it takes in the skull under examination should be determined and the

section then made close to its concave side A knife is to be inserted into the nostril of that side and carried upwards through the cartilaginous part of the nose to the nasal bone. The soft palate is to be divided in the middle line The section is to be completed by sawing through the hard palate and the bony roof of the nasal cavity a little to the required side of the median plane Every care is to be taken to preserve the septum of the nose intact.

The **nasal septum** is to be examined on the side on which it is intact. It divides the cavity of the nose into two chambers, the **nasal cavities.** As a rule it is not placed accurately in the median plane but almost always (in 75 per cent. of subjects) *shows a deviation or bulging or* a pointed projection to one or other side more frequently the deviation

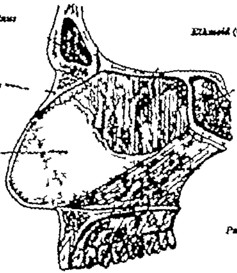


FIG 101

A diagram of the nasal septum. The cribriform plate of the thmoid bone is to be named.

is to the right side. Immediately above the orifice of the nostril there is a slight depression on the septum. This part forms the medial wall of the **vestibule of the nasal cavity** (Fig 101) it is covered with skin continuous with that of the exterior and carries a number of stiff hairs named vibrissæ. The other parts of the septum are covered with mucous membrane which is closely adherent to the subjacent periosteum forming with it a muco-periosteum. Two areas may be distinguished on the mucous membrane namely a lower **respiratory area** and a much smaller upper **olfactory area.** The mucous membrane of the respiratory area is thick, spongy and highly vascular and contains numerous mucous glands the minute orifices of the ducts of which can be detected with the naked eye The olfactory area of the septum which comprises not more than its upper third, is that in which

the fibres of the olfactory nerves arise the mucous membrane is not so thick and the glands are smaller and in the fresh state it is yellowish in colour

A minute opening may be found in the mucous membrane on the lower and anterior part of the septum, immediately behind the vestibular area. It leads into a narrow canal which passes a short distance backwards and ends blindly and is of interest since it is the rudimentary representative of the organ of Jacobson (vomero-nasal organ), a structure which is highly developed in most of the lower mammals as an accessory organ of smell.

The muco-periosteum is to be stripped from the surface of the septum to expose the parts which enter into its formation. These parts are the **vertical plate of the ethmoid** above and behind the **vomer** bone below and behind, and the **septal cartilage** in front. Small parts of other bones, however are also to be found in it thus, above and behind there are the crest and the rostrum of the sphenoid above and in front is the nasal spine of the frontal bone and below along the lower margin, there is the crest formed by the apposition of the palatal processes of the maxillary and palatine bones of the two sides. The deviation of the septum from the median plane will probably be most marked along the line of union of the perpendicular plate of the ethmoid and the vomer

The **septal cartilage** (Fig. 101) is a broad, irregularly four-sided plate. It fills the wide angular gap between the vertical plate of the ethmoid and the vomer to each of which it is attached. In front and above, it is in contact with the suture between the two nasal bones. Below this it is related to the two upper lateral cartilages of the nose with the upper parts of which it is directly continuous, and still lower down it appears in the interval between the two lower lateral cartilages (p. 35). The lower anterior border of the cartilage is free and extends backwards to the nasal spine of the maxilla (Fig 69). The anterior angle is blunt and rounded; it does not reach to the point of the nose which is formed by the lower lateral cartilages (p. 35).

The septal cartilage and the thin parts of the bones of the septum are to be removed in small pieces. This must be done carefully and so as to preserve intact the muco-periosteum which covers the opposite side of the septum for in it the nerves and vessels of the septum are to be examined.

The nerves which are distributed in the septum are (1) The medial group of olfactory nerves which are to be found in the olfactory area of the mucous membrane. They are difficult to discover, however except in fresh part and even then are so soft that it is hardly possible to isolat them without special preparation of the specimen. They lie in the muco-periosteum and proceed upwards in grooves on the vertical plate of the thmoid bone and enter the cranial cavity through the medial series of openings in the cribriform plate. (2) The long spheno-palatine or naso-palatine nerve, a long slender twig, is easily found on the deep surface of the muco-periosteum. It arises from the spheno-palatine (Meckel's) ganglion (p. 206) and enters the nasal

cavity through the spheno-palatine foramen. On the septum it passes downwards and forwards in a shallow groove on the surface of the vomer bone to the median incisive foramen; and having passed through this opening the nerves of the two sides unite in a plexus from which branches are given to the mucous membrane of the anterior part of the hard palate (3) A few short spheno-palatine nerves pass to the back part of the septum from the spheno-palatine ganglion. (4) The medial nasal branches of the anterior ethmoidal nerve (p. 190) are distributed over the anterior part of the septum as far down as the vestibule.

The arteries which supply the septum are: (1) The posterior septal arteries are branches of the spheno-palatine artery which itself is the terminal branch of the internal maxillary artery One of them, larger than the others, is distributed in company with the long spheno-palatine nerve It can usually be discovered if the injection has been good. (2) Small septal branches are derived from the anterior and posterior ethmoidal arteries (p. 188). (3) The septal branch of the superior labial artery (p 44) supplies the anterior part of the septum.

The muco-periosteum of the septum is to be cut away with scissors The general shape of the nasal cavity and the structure of its lateral wall can now be examined on the two sides.

The **nasal cavities**, placed one on each side of the septum, are very irregular in shape owing to the projection of the conchæ into them from the lateral walls. Their upper parts are narrow almost slit-like from side to side the width increases, however from above downwards and especially below the middle concha, so that in vertical section they are triangular in shape (Fig 66) They are about two inches in vertical height and two and a half inches in antero-posterior length They open in front on the face through the anterior nares or nostrils and behind into the naso-pharynx through the posterior nares or choanæ. The roof of each cavity is very narrow 1 to 2 mm. in width. When the mucous membrane which covers it is pulled away its middle part is seen to be formed by the cribriform plate of the ethmoid bone through which the olfactory nerves may be seen to pass. In front of and behind the cribriform plate the roof slopes downwards the anterior sloping part is formed by the nasal spine of the frontal bone and the nasal bone while the posterior part is formed by the anterior and under surfaces of the body of the sphenoid bone (Fig 102) The floor of the cavity is concave from side to side and slopes slightly downwards and backwards It is formed by the palatal processes of the maxilla and palatine bone (Fig 102) In its anterior part, just below the position of the organ of Jacobson on the septum, a depression of the mucous membrane into the incisive canal may be found it is the vestige of an extensive communication between the cavities of the mouth and nose which is present in the human embryo and in many of the lower mammals

The **lateral wall** of the nose is divisible into three regions namely the vestibule, the atrium of the middle meatus and the region of the conchæ. The conchæ three in number or often four are thin curled

plates of bone covered with mucous membrane which project into the back part of the cavity of the nose and curve downwards each bone overhangs a space called a meatus.

The **vestibule** is the depressed oval area immediately above the nostril; it is partly subdivided into upper and lower parts by a blunt ridge (Fig. 103). It is covered with skin which is continuous with that of the exterior and carries a number of short hairs named *vibrissae*. The **atrium** of the middle meatus lies above the vestibular area and immediately in front of the middle meatus. It is slightly hollowed out, but at its upper part there is a flattened

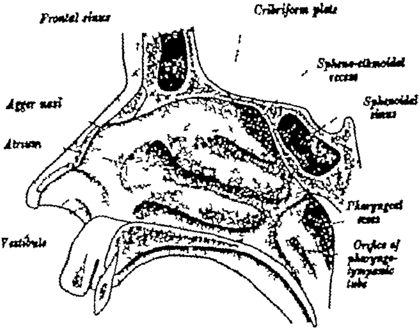


FIG 103
The lateral wall of the nasal cavity

elevation, the **agger nasi**, which run downwards and forwards close to the nasal bone; it represents an add tional concha which is present in some mammals. The slight furrow abo the agger which leads to the olfactory area of the lateral wall, is named the **sulcus olfactorius**.

The mucous membrane which vers the lateral wall of the nasal cavity except the vest bular area which is lined with skin, is closely blended with the subjacent periosteum and forms with it a muco-periosteum. It is continuous with the mucous membrane of the pharynx behind and with the linings of th naso-lacrimal duct and the air sinuses which open into the nasal cavity As on the septum, there are two

areas of it on the lateral wall, an upper **olfactory area** on and above the superior concha and a lower **respiratory area** which comprises the rest of the wall. The olfactory mucous membrane is soft and delicate and in the fresh state is yellowish in colour but the covering of the respiratory area, and especially over the middle and inferior conchæ is thick and spongy. This condition is due to the presence of large venous plexuses which are best developed over the inferior concha and cause its mucous covering to be irregular and nodulated on the surface. The dissector should strip a small piece from the bone to appreciate its thickness. The mucous membrane everywhere contains numerous mucous glands, the minute orifices of which are visible to the naked eye and they and the venous plexuses are surrounded by bundles of plain muscle fibres. The membrane thus resembles a cavernous tissue and when engorged swells so much as to obliterate the cavity. In some people it is extremely sensitive and reacts to very slight noxious stimulation.

The **nerves** which are distributed on the lateral wall of the nose are: (1) The **lateral group of olfactory nerves** arise from the olfactory cells in the olfactory mucous membrane over the upper third of the lateral wall. They become grouped in bundles which pass upwards in grooves or canals in the bone and enter the cranial cavity through the lateral foramina of the cribriform plate. (2) The **posterior nasal nerves** are branches of the spheno-palatine ganglion and reach the nose through the spheno-palatine foramen. This opening will be exposed if the mucous membrane is stripped from the region just behind the posterior end of the middle concha. The long spheno-palatine nerve of the septum should be followed backwards into it, and then, by careful dissection, the delicate posterior nasal nerves may be found and traced to the mucous membrane over the upper and middle concha. (3) The **lateral nasal branch** of the anterior ethmoid nerve (p. 196) can be exposed in a groove on the deep surface of the nasal bone. It supplies the anterior part of the lateral wall. (4) Two small nasal branches are derived from the anterior palatine nerve (p. 205). They are distributed over the back parts of the middle and inferior conchæ.

The **spheno-palatine artery**, the terminal branch of the internal maxillary artery, is the chief vessel on the lateral wall of the nose, which it reaches through the spheno-palatine foramen. Small twigs, which will hardly be found, are also given to the lateral wall from the anterior and posterior ethmoidal arteries (p. 198) and the descending palatine artery (p. 206).

The **conchæ** (turbinate bones or turbinals) are usually described to be three in number, two of which, the superior and middle bones, are parts of the ethmoid bone and one, the inferior concha, is an independent bone which articulates with the maxilla and palatine bone. Each concha has an upper attached border and a lower rolled free border as is to be seen on a dried preparation, and it overhangs and partly separates from the general cavity of the nose a groove-like space which is known as the **meatus**. The conchæ and the meatuses are to be examined.

them in front. They are two irregular cavities, very variable in size, which lie between the two tables of the frontal bone above the root of the nose and the medial third of the supra-orbital margins; frequently they also extend backwards into the roof plates of the orbits. They are separated from one another by a thin bony septum which is usually deflected to one or other side of the middle line; they are thus seldom symmetrical; occasionally in 10 per cent. of subjects, one sinus is wanting. They develop in the first year but remain small until the permanent teeth begin to erupt; then they rapidly increase in size and reach their full development about twenty-five years of age. As a rule they are larger in men than in women, their average size in them being 30 mm. in vertical height, 25 mm. in horizontal width, and 18 mm. in depth. A sinus of such a size is marked on the surface by a triangle with one point at the nasion, one point 25 mm. vertically above the nasion, and one point at the junction of the medial third and lateral two-thirds of the supra-orbital margin. The thinnest part of the floor of the sinus is under the medial end of the supra-orbital margin, medial and posterior to the attachment of the pulley of the superior oblique muscle. The duct of the sinus, about three-quarters of an inch long, opens into the middle meatus, usually by the infundibulum into the hiatus semilunaris; sometimes, however, it opens in front of the hiatus.

The **superior concha**, a part of the ethmoid bone, is very short. It is placed obliquely on the upper and posterior part of the lateral nasal wall. Its free border begins in front below the middle of the cribriform plate and it ends behind immediately below the body of the sphenoid bone. It is covered with olfactory mucous membrane which is thinner and much less vascular than that in the respiratory area. If it is turned aside with scissors the **superior meatus**, a short narrow fissure, will be exposed; in its upper and anterior part is the opening or openings of the poster[illegible] **ethmoidal cells**. Above the superior concha there is a triangular d[illegible]pression, the **spheno-ethmoidal recess**. As a general rule at le[illegible]t in [illegible] per cent. of subjects it is bounded above by a small f[illegible]urth concha, the **concha suprema**, which joins the superior concha in front. In the poster[illegible] part of the recess there is the opening of the **sphenoidal air sinus** (Fig. 103); the opening may be circular or converted into a slit [illegible] a f[illegible]ld of muc[illegible] membrane.

The **ethmoidal air cells** are [illegible] merous thin walled cells in the lateral mass of th[illegible] ethm[illegible]d bone man[illegible] [illegible] th[illegible] [illegible]t the marginal part of the mass being completed by the surr[illegible]unding bones [illegible] th[illegible] [illegible]hich [illegible]t articulates. They lie bet[illegible]een the [illegible]pper part [illegible]f th[illegible] nasal [illegible]t[illegible] and the medial wall of the orbit, and are grouped [illegible] th[illegible]ee sets, [illegible]ter[illegible] middle and posterior [illegible]hich [illegible]pen separately int[illegible] the nose.

The **sphenoidal air sinuses** are t[illegible] [illegible]n [illegible]tal[illegible] [illegible]nd [illegible]ccupy the body of the sphenoid bone [illegible] [illegible] part [illegible] [illegible]ng t[illegible] their size [illegible]hich greatly varies. They are separated f[illegible]m [illegible] another [illegible] [illegible] septum [illegible]hich is seld[illegible]m in the m[illegible]ddle l[illegible]ne [illegible] [illegible] [illegible] [illegible]mmetry frequentl[illegible] one sinus is larger than the [illegible]ther. [illegible] [illegible] [illegible]hind the [illegible]pper part [illegible] the nasal cavities and [illegible]pen int[illegible] them [illegible] [illegible] in the upper parts of their ant[illegible]r[illegible] walls.

THE BRAIN AND SPINAL CORD

Introduction.—The brain and spinal cord, the two parts of the central nervous system, are developed, it is well to recall, from the neural tube. This tube, derived from the embryonic ectoderm, is at first of uniform structure and nearly uniform size in its whole length, but early in its development its cephalic part rapidly enlarges and becomes subdivided into three regions; the three regions are the three primary parts of the brain, the fore-brain, the mid-brain, and the hind brain, and the unenlarged part is the spinal cord (Fig 104)

The further development of the spinal cord consists in the thickening and differentiation of its wall, the process being practically uniform along its whole length its structure in the adult therefore is practically identical at all levels and its functions practically the same. (The brain, on the other hand, is a composite formation with a regional distribution of a multiplicity

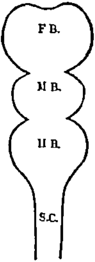


Fig 104.

The primary parts of the central nervous system.

of functions; and, when it has developed, there are great differences of structure in its parts.) The essential processes of development, however are, as in the spinal cord, the thickening and differentiation of its walls; but they differ greatly in the three parts of the brain. The primary parts of the brain develop as follows

1 **The Fore-brain.**—Two diverticula are formed from the lateral walls of the front part of the fore-brain and rapidly growing in size, soon assume the appearance of independent cavities (Fig 105). Their walls, which become exceedingly thick, form the **cerebral hemispheres**, their cavities are the **lateral ventricles**, their openings into the median cavity are the **interventricular foramina**, and the strip which connects them in front and itself undergoes little development is the **lamina terminalis**. The hinder part of the fore-brain, median in position and between the two cerebral hemispheres, develops much less than them; but its lateral walls thicken and form the **thalami**. Its cavity narrowed from side to side by the thalami, is the **third ventricle**;

it communicates with the lateral ventricles by the interventricular foramina and its front wall is the undeveloped lamina terminalis.

2. The Mid-brain.—The mid-brain develops by a nearly uniform thickening of its walls, though with differences in structure in its dorsal and ventral parts; and its cavity greatly narrowed in proportion to them, forms the cerebral aqueduct, a narrow tubular channel connecting the third ventricle in front with the cavity of the hind-brain behind.

3. The Hind-brain.—The hind-brain subdivides into two regions but its cavity which is the fourth ventricle, remains a single space. The ventral

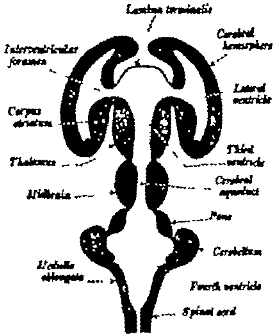


FIG. 103.

The development of the primary parts of the brain.

part of the front region thickens and forms the pons and in its dorsal part the cerebellum develops; the medulla oblongata develops from the hinder region and is continuous with the spinal cord.

THE BRAIN

A sat sfactory examinat on of the br n can only be made if the student dissect tw brain at the same time and f it has not been possible t bt in a second brain from the post mortem room and ha e it injected nd h rdened, two g oups f tudents should rrange to dissect together

The **general anatomy of the brain** is to be examined first and to this end on one specimen the arachnoid and pia mater that cover the brain and the large blood vessels that ramify over it are to be removed. The removal is to be begun at the margins of the lateral surfaces of the cerebral hemispheres and carried towards the middle parts and, these surfaces having been cleaned, there is then little trouble in stripping the upper parts of the medial surfaces. There will be difficulty however in cleaning the under surface of the brain and at the same time preserving intact the cranial nerves which are attached to it it is better therefore meantime to leave the meninges and vessels there undisturbed.

When looked at from above the parts of the brain that are seen are the two **cerebral hemispheres**, and together they form an ovoid mass the greatest transverse diameter of which is nearer the posterior end. Their surfaces are everywhere richly folded the folds are the **convolutions** or **gyri** and the clefts between them the **fissures** or **sulci**. The hemispheres are separated from one another by the **great longitudinal fissure** the falx cerebri was withdrawn from it as the dura mater was reflected. The fissure completely separates the flat medial surfaces of the hemispheres in front and behind, but if it is widely opened it will be seen to be interrupted, and the hemispheres to be connected together for about the middle half of their length by an arched commissural band of white brain substance, the **corpus callosum** (Fig 107) The convex lateral surfaces of the hemispheres are directed towards and through the meninges, closely adapted to the vault of the skull and, especially at the lower parts, the convolution pattern of the brain is reproduced on the interior of the bones. The inferior surface of each hemisphere is divided into anterior and posterior parts by the **lateral** (Sylvian) **fissure**, a deep transverse cleft which runs laterally across it onto the lateral surface the membranes and blood vessels are to be removed from it and then stripped forwards to the **frontal pole** The anterior or orbital area of the hemisphere which is in front of the lateral fissure rests on the floor of the anterior fossa of the skull the posterior area lies on the floor of the middle fossa (temporal area) and, behind this on the upper surface of the tentorium cerebelli which separates it from the cerebellum. The tentorial area is distinctly concave as will be seen if the cerebellum is raised from it.

The **base of the brain**, looked at as a whole (Fig 106) is irregular but it is well adapted to the uneven base of the skull on which it lies the main sub-divisions of the brain are to be recognised on it, each part being cleaned of its coverings as it is defined. The **medulla oblongata** or **bulb** is the short conical posterior part continuous with the spinal cord. It is continuous in front with a more massive part largest in the middle line the **pons Varolii**, on whose surface the fibres quite evidently run transversely and form a bridge between the two sides of the cerebellum. In the middle line of the medulla there is its **anterior fissure** it ceases abruptly at the lower border of the pons in

a small pit, the **foramen cæcum**. On each side of the fissure and lying parallel to it there is an eminence, the **pyramid** of the medulla. The pyramids are larger at their upper than their lower parts, for when followed downwards the majority of the fibres which form them cross the anterior fissure to the opposite side and sink into the substance of the spinal cord. This **decussation of the pyramids** will be seen if the *lips of the fissure are opened*; the decussating fibres cross in flattened bands.

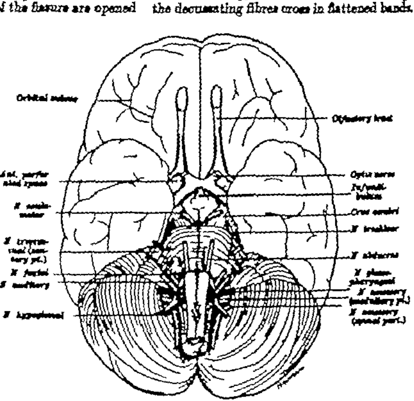


FIG. 108.

A diagram of the base of the brain. The cranial nerves are to be coloured and the parts of the brain are to be named as they are described in the text, for example the pyramids of the medulla and the decussation of the pyramids.

A second swelling on each side of the medulla, the **olive**, lies lateral to the upper part of the pyramid; it is oval in shape, has uneven edges, and is about half an inch in length. The areas of the medulla posterior to the olives are the **restiform bodies**; they are easily followed upwards into the cerebellum.

There is a broad shallow groove in the middle line of the pons; it lodges the basilar artery and is named the **basilar groove**. The transverse fibres on the surface of the pons will be seen to emerge from the groove and, passing to one or other side, to be collected into a

compact bundle named the **brachium pontis** which sinks into the cerebellum.

The **cerebellum** is easily recognised: it is of considerable size and its surface is traversed by closely set curved parallel fissures. It lies below the tentorial parts of the cerebral hemispheres and in the skull is separated from them by the tentorium cerebelli; and it lies behind (dorsal to) the pons and medulla which are embedded in a fossa on its ventral surface. It consists of two lateral parts, the **cerebellar hemispheres**, and a median part, the **vermis**, which joins them together.

The three parts, the medulla, pons, and cerebellum, together constitute the **hind-brain**, the cavity of which is the **fourth ventricle** (Fig. 107).

There is a deep hollow on the base of the brain in front of the pons bounded at the sides by the temporal parts of the cerebral hemispheres. In it the following structures are to be recognised by carefully removing the membranes and large vessels from it. The **cerebral peduncles** or **crura cerebri** are two large white columns, grooved on the surface, which emerge from the cerebral hemispheres and, converging as they pass downwards, enter the upper margin of the pons close together. The **optic nerves** which commence in the retinae of the eyeballs and enter the cranial cavity from the orbits through the optic foramina were divided behind the foramina in the removal of the brain. They converge when followed backwards on the base of the brain and are seen to be joined together by a short transverse part, the **optic chiasma**; and from the chiasma they are continued laterally and backwards as the **optic tracts** which cross the cerebral peduncles as they leave the cerebral hemispheres. The cerebral peduncles, the optic tracts, and the optic chiasma bound a deep diamond-shaped space, the **interpeduncular fossa**, which since it overlies the sella turcica in the base of the skull is often known as the **suprasellar space**. It forms the floor of the third ventricle of the brain; and in it the following structures are to be seen: (1) The **corpora mamillaria** are two white bodies about the size of small peas placed side by side between the cerebral peduncles. (2) The **posterior perforated space** is the triangular area which lies behind the corpora mamillaria in the angle between the cerebral peduncles: it has several small openings in it for the passage of arteries into the substance of the brain. (3) The **tuber cinereum** is a small rounded elevation in the middle line behind the optic chiasma and in front of the corpora mamillaria. It is a hollow swelling, its cavity being continuous with the third ventricle; and projecting from its anterior part there is a short hollow stalk-like process, the **infundibulum**, which is attached by its peripheral end to the pituitary gland. It was severed from the gland, which was left in the sella turcica, in the removal of the brain.

The great longitudinal fissure will be seen in front of the optic chiasma between the orbital areas of the cerebral hemispheres. If the anterior edge of the chiasma is gently pulled backwards a thin membranous lamina will be seen passing upwards from it into the

fissure this is the **lamina terminalis**, the front wall of the third ventricle The **olfactory bulbs** and the **olfactory tracts** are to be found on the orbital surface of the hemispheres near the longitudinal fissure and parallel with it the bulbs are oval expansions which receive the olfactory nerves on their under surface and the tracts are narrow white bands continued backwards from them. Each tract is widened *at its posterior end, and near the beginning of the lateral fissure is* attached to the cerebral hemisphere by medial, intermediate and lateral roots. The **anterior perforated space** lies behind and between the medial and lateral roots of the olfactory tract. It is a triangular area of the surface of the brain, limited medially by the optic chiasma and the optic tract, and in it there are numerous openings for the passage of small arteries into the substance of the hemisphere.

The Superficial Origins of the Cranial Nerves.—There are twelve pairs of nerves attached to the brain. Each nerve is described to have a *deep* and a *superficial* origin The **deep origin** is the *group of cells* within the substance of the brain with which the fibres of the nerve are connected. This group of cells *is known as the* ***nucleus of the nerve.*** The nuclei are of course of two kinds, namely the sensory nuclei round which the sensory or ingoing nerve fibres end and the motor nuclei from which the motor or outgoing fibres arise. The **superficial origin** of the nerve is the place at which the nerve fibres enter or leave the surface of the brain, and it is these places of superficial attachment which are to be studied at the present time (Fig. 106). The general description of the distribution of the nerves given on p. 11 is to be read at the same time

The **olfactory nerves**, though twenty in number on each side are not readily seen. *They are fine non medullated filaments which arise in the olfactory area* in the upper part of the nasal cavity and end in the under surface of *the olfactory bulb, which they reach by passing through the foramina* in the cribriform plate of the ethmoid bone (p. 274)

The **optic nerve** is a large round trunk which arises in the retina of the eyeball and leaves the orbit through the optic foramen. On the base of the brain it passes backwards and medially to the optic chiasma.

The **oculo-motor nerve** is to be found in the interpeduncular fossa and followed to its attachment on the medial side of the cerebral peduncle at the oculo-motor groove

The **trochlear nerve** leaves the brain on its dorsal side, behind the corpora quadrigemina on the dorsal surface of the mid brain. Its point of attachment cannot be seen at present but it is readily recognised as a delicate nerve which winds round the lateral side of the cerebral peduncle It is best found by gently raising the cerebellar hemisphere and then, on the lateral surface of the peduncle its position the nerve will be seen.

The **trigeminal nerve** [illegible] bulky nerve which is attached to the lateral part of the pons nearer the upper than the lower border *It consists of two roots,* a large sensory root the fibres of which are loosely bound together and a small compact *motor root* which lies on its *medial side*

The **abducent nerve** emerges [illegible] between the lower border of the pons and the lateral part of the pyramid of the medulla.

The **facial nerve** is attached at the lower border of the pons immediately above the restiform body this region is known as the cerebello-pontine angle, being bounded in front by the pons and laterally by the cerebellum. The facial nerve has two roots, the larger motor root being separate from and on the medial side of the smaller sensory root. The two roots join one another in the internal auditory meatus.

The **auditory nerve** lies immediately on the lateral side of the seventh nerve. It has two parts, the cochlear and vestibular parts, and these embrace the restiform body at the lower border of the pons in the cerebello-pontine angle

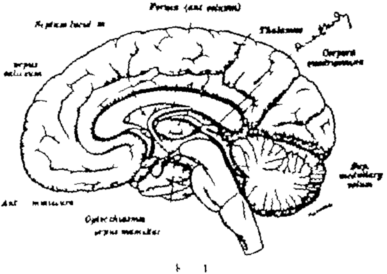
The **glosso-pharyngeal, vagus,** and **accessory nerves** are formed from a continuous row of rootlets which are attached to the medulla in the groove between the olive in front and the restiform body behind. The rootlets extend, in linear series, along the whole length of the medulla, and passing laterally become grouped in three sets which unite to form, from above downwards, the ninth, tenth, and eleventh nerves. The eleventh nerve, however has a second part, which springs from the spinal cord as low down as the level of the sixth cervical nerve by a series of rootlets which are attached to the cord behind the ligamentum denticulatum. The spinal part of the nerve ascends in the vert bral canal and enters the skull through the foramen magnum to join the medullary part.

The **hypoglossal nerve** is formed from a series of fila which are attached to the medulla between the olive and the pyramid. The fila form a linear series continuous with the fila of the anterior root of the first cervical nerve, but between the two sets of rootlets the vertebral artery passes forwards to the front of the medulla.

The **general relations of the parts of the brain** are now to be studied on the medial face of the sectioned brain. The brain is to be laid base downwards and firmly held A large brain-knife is then to be entered in the middle line of the great longitudinal fissure and the whole brain cut into lateral halves with one sweep of the knife If the student is in any doubt the assistance of a demonstrator is to be sought as it is important that the third and fourth ventricles of the brain should be accurately divided.

The medulla the pons and the cerebellum, which together constitute the hind brain, will be seen to form the boundaries of its tent-shaped cavity the **fourth ventricle** (Fig 107) The medulla and the pons form the anterior wall or the floor of the cavity and the cerebellum, which is seen to be formed of a central core of white matter overlaid everywhere by a mantle or cortex of grey matter lies in the roof. It forms however only a part of the roof, for above and below it the roof is formed by thin layers, the **superior and inferior medullary vela,** and the front and back parts of the cerebellum rest on them the inferior velum is very thin. The medulla and the pons are seen to be in the main, continuous with one another but on each side the **restiform body** of the medulla and the **brachium pontis,** which is formed by the gathering together of the transverse fibres of the pons, are to be followed backwards into the cerebellum where they end. The cavity of the fourth ventricle is continued downwards into the

central canal of the spinal cord, and when followed upwards is continued into the **cerebral aqueduct** which tunnels through the mid brain (Fig 10) Behind the aqueduct and forming the dorsal part of the mid brain are the **corpora quadrigemina**, four rounded elevations, two on each side the superior and inferior pairs and in front of the aqueduct and forming the ventral part of the mid brain, there are the thick ma[illegible]ses of the **pedunculi** or **crura cerebri**, each of which obviously con[illegible]titutes the connection between the cerebral hemisphere in front and the hin[illegible] brain and [illegible]pinal cord behind. The cerebral aqueduct opens in fr[illegible]nt into a narrow irregularly shaped cavity the **third ventricle**. The sid[illegible] wall[illegible] of the third ventricle are formed by the **thalami** and the



[illegible] 1

[illegible] brain The [illegible]

[illegible] **lamina terminalis** [illegible] **anterior commissure**, [illegible] **optic chiasma** [illegible] **tuber cinereum** with the infundibulum [illegible] **corpora mamillaria**. The [illegible] **pineal gland** [illegible] the uppe[illegible] [illegible] **interventricular foramen** [illegible] **lateral ventricle** [illegible] the [illegible] [illegible]phere

there are to be recognised (1) The **corpus callosum** which is in longitudinal section. It is an arched white band which connects the cerebral hemispheres and interrupts the longitudinal fissure between them. Its posterior end the **splenium**, is thick and rounded. Its anterior end, the **genu**, bends on itself and runs downwards and backwards as a much thinned part, the **rostrum**, to the anterior commissure (Fig 107) (2) The **fornix** can be identified as the anterior boundary of the interventricular foramen and followed backwards over the upper surface of the thalamus to the under surface of the splenium of the corpus callosum to which it is adherent (3) The **septum lucidum** is the thin membrane which fills the interval between the corpus callosum above and the fornix below and is attached

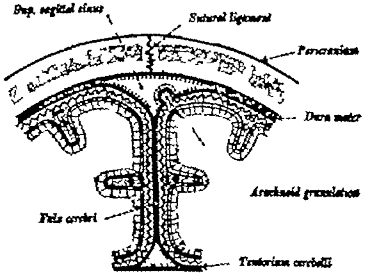


FIG. 108

A diagram of the meninges of the brain.

to them. If the brain has not been sectioned accurately in the middle line the septum lucidum will be absent on one side and the lateral ventricle will be opened

The student must now turn to the second brain and examine on it the **membranes and blood vessels of the brain.**

The brain like the spinal cord, is enclosed in three **meninges**, the dura mater the arachnoid and the pia mater The **dura mater**, the dense outer protective covering has already been studied (p 1 4) it remains now to examine the **arachnoid** and the **pia mater** which invest the brain more closely They are as can be seen, delicate membranes separated from one another but incompletely by the **sub-arachnoid space** and they are concerned with giving support to the blood vessels of the brain and providing the cavity for the cerebro-spinal fluid.

The two layers together are often referred to as the lepto-meninx and the dura mater as the pachy meninx.

The **arachnoid mater** is a soft thin transparent membrane which is loosely wrapped round the brain. It is separated from the dura mater by a capillary interval, the **sub-dural space**, occupied by a film of lymph-like fluid which moistens the surfaces. It is separated from the pia mater by the **sub-arachnoid space** which contains the cerebro-spinal fluid and the ramifications of the larger branches of the cerebral arteries and veins; the space is crossed by a meshwork of fine trabeculæ which connects the two membranes together. The arachnoid, unlike the pia mater, does not *follow the irregularities of the surface of the brain*. It is in close contact with the pia mater over the summit of the cerebral convolutions and, the trabecular meshwork being dense, it is hardly possible there to separate the two layers; but it bridges over the fissures, the depressions, and the intervals between the parts of the brain, and there, separated from the pia, it is readily recognised. It is however carried into the lateral fissure of the cerebral hemisphere and by the partitions of the dura mater between the parts of the brain they separate (Fig. 108). At some of the places it bridges, particularly on the base of the brain, it forms extensive sheets and beneath it there are large expansions of the sub-arachnoid space known as **cisternæ**. In them the trabecular tissue is much reduced and in the form of long filamentous threads. The cisternæ communicate freely with one another and with the narrow spaces on the surface of the cerebral hemispheres, and as they serve for the accumulation of the cerebro-spinal fluid the larger of them require special mention. Their position is to be identified on the first brain as they are opened up on the second brain.

The **cisterna cerebello-medullaris** (cisterna magna) is the largest of the cisternæ. It is roofed by the sheet of arachnoid which bridges the wide interval between the under surface of the cerebellum and the posterior surface of the medulla oblongata. Its floor is formed by the pia mater which covers the medulla and the inferior medullary velum, that is, the hinder part of the roof of the fourth ventricle. In the roof of the ventricle there are three foramina, which will be described later, and the ventricular system of the brain communicates through them with the cistern. The **cisterna pontis** lies round the anterior surface of the pons and medulla, and in it are lodged the vertebral and basilar arteries. It communicates at the sides with the cisterna magna and below with the sub-arachnoid space round the spinal cord. The stem of the brain, therefore, is surrounded by the sub-arachnoid space. The **cisterna interpeduncularis** is formed by the arachnoid bridging over the interpeduncular fossa. The large arteries which supply the cerebral hemispheres lie in it and the posterior perforated substance forms its posterior wall. It communicates freely with the sub-arachnoid channels on the surface of the cerebral hemispheres and forms reservoirs for the large spinal fluid in them; the **cisternæ laterales**, which lie in the lateral fissures and contain the middle cerebral arteries, and the **cisterna chiasmatis**, which lies in front of the optic chiasma and contains the anterior cerebral arteries, are the largest communicating channels.

It will be remembered that [illegible] the skull [illegible] a number of small rounded [illegible] bodies were seen on the dura

mater close to the sides of the middle part of the superior sagittal sinus, and that when the sinus and its lateral lacunæ were opened they were also found projecting into them (p 174). They are the arachnoid granulations (Pacchionian bodies) and it was then stated that though at first they appear to belong to the dura mater they are in fact enlarged arachnoid villi. The whole surface of the arachnoid is beset with villi microscopic in size and not perceptible but after two years of age those of them that are related to the dural sinuses and their lateral lacunæ enlarge and with age increase in size, and form the masses known as the arachnoid granulations.

The arachnoid granulations are cauliflower-like masses of arachnoid villi which project into the dural sinuses and their lateral lacunæ; they are most numerous at the superior sagittal sinus, but are also found at the transverse,

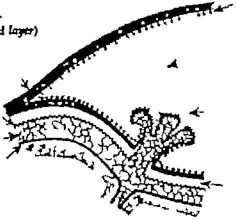


Fig 100

A diagram of the structure of the arachnoid granulations.

cavernous, and superior petrosal sinuses though they may not be present at them until old age. They are attached to the arachnoid by a narrow stalk and contain within them an extension of the sub-arachnoid space which is traversed by a rich interlacement of the sub-arachnoid trabecular tissue. The covering of th stalk is single layer of flattened mesothelial cells, but over the pices of the villi there are several layers of cells which form a cap for them. These apical cells (meningocytes) are in direct contact with the endothelium of the sinuses and are fused with it, the fibrous dura mater being absent over them. There is, therefore, no fibrous tissue between the apical parts of the granulations and the blood stream; the dura mater thins over the stalk and is perforated by the apical parts (Fig 100). The arachnoid granulations probably aid the arachnoid villi in transmitting the cerebro-spinal fluid from the sub-arachnoid space into the blood stream.

The cerebro-spinal fluid is derived from the choroid plexuses of the ventricles of the brain; the exact manner of its formation, however is not yet clear that is, how much it is to be considered a simple filtrate from the

the **basilar artery** The basilar artery passes forwards in the basilar groove in the middle line of the pons, and at its anterior border bifurcates into the right and left **posterior cerebral arteries** (Fig. 110) these vessels turn backwards round the cerebral peduncles to the under surface of the cerebral hemispheres.

The **internal carotid artery** of each side has already been traced as far as the anterior clinoid process of the sphenoid bone, at which level it was divided in the removal of the brain. On the base of the brain the cut end of the artery is to be secured on the lateral side of the optic chiasma and close to the medial end of the stem of the lateral fissure It pierces the arachnoid there and almost at once divides into its two terminal branches, the **anterior and middle cerebral arteries** (Fig 110) The anterior artery is the smaller vessel and runs forwards and medially above the optic chiasma (above when the base of the brain is turned downwards) and turning sharply upwards enters the great longitudinal fissure. The two anterior cerebral arteries there lie close to one another and are connected by a short transverse stem, the **anterior communicating artery** The middle cerebral artery the larger branch and the more direct continuation of the parent stem, passes laterally behind the anterior perforated space into the lateral fissure in which it is conducted to the lateral surface of the hemisphere Near its termination each internal carotid artery (sometimes the middle cerebral artery) gives origin to the **posterior communicating artery** which runs backwards below the optic tract and on the surface of the cerebral peduncle and joins the posterior cerebral artery (Fig 110). The posterior communicating arteries establish a free anastomosis between the carotid and vertebral systems of cerebral arteries and complete a remarkable connexion between the vessels on the base of the brain which is named the **circulus arteriosus** (circle of Willis) The circle is irregularly polygonal in outline (Fig 110) and is formed in front by the anterior communicating and anterior cerebral arteries, and then, in succession backwards, by the internal carotid, posterior communicating, posterior cerebral, and basilar arteries. This direct communication between the cerebral trunks is almost constant though irregularities in the size of the participating vessels are often met with, and is probably of importance in maintaining a uniform flow of blood to the parts of the brain. The circulus arteriosus lies in the cisterna interpeduncularis it is to be exposed by removing the arachnoid mater

The **branches of the cerebral arteries** for the most part spread themselves over the surface of the brain in the sub-arachnoid space but the finer twigs which are formed by their subdivision enter the pia mater and ramify in it before entering the substance of the brain On the cerebral hemispheres these vessels are named the **cortical branches**, and they carry with them into the brain sheaths of the pia and arachnoid mater and between the sheath a perivascular extension of the sub-arachnoid space which contains cerebro-spinal fluid this space is usually known as the Virchow Robin space and it

do not anastomose with one another they belong therefore to the class of end arteries (see Vol. I. p 47) There is a third group of branches of the cerebral arteries named the choroidal branches which are distributed in the choroid plexuses of the ventricles of the brain they cannot be seen at present but will be studied at a later period.

The details of the branches of the cerebral arteries which the student is to dissect are as follows —

Branches of the Vertebral Artery (Fig 110).—In the intra-cranial part of its course the vertebral artery gives off the following branches: (1) The **posterior spinal artery** passes down the spinal cord in front of the posterior nerve roots. More frequently this artery is a branch of the posterior inferior cerebellar artery (2) The **posterior inferior cerebellar artery** is the largest branch. It is a tortuous vessel and passes backwards round the upper part of the medulla, among the roots of the hypoglossal and vagus nerves, and then over the restiform body to the under surface of the cerebellum. It divides there into two branches; the medial branch is distributed in the notch between the cerebellar hemispheres and the lateral branch on the posterior part of the under surface of the hemisphere. Branches from this artery supply the choroid plexus of the fourth ventricle (3) The **anterior spinal artery** arises near the lower border of the pons. The vessels of the two sides, usually of unequal size, converge as they descend on the front of the medulla and unite with one another at the level of the foramen magnum. The median vessel thus formed extends downwards in the mouth of the anterior fissure of the spinal cord. (4) The **medullary arteries** are minute vessels which spring from the vertebral artery and its branches and are distributed to the substance of the medulla oblongata.

Branches of the Basilar Artery (Fig 110).—The branches of the basilar artery pass laterally from each sid of the vessel. They comprise the following vessels (1) The **pontine arteries** are numerous small twigs running transversely on the surface of the pons and entering its substance. (2) The **internal auditory artery** is a long slender vessel which accompanies the auditory nerve into the internal auditory meatus and supplies the internal ear It will be found among the pontine branches. (3) The **anterior inferior cerebellar artery** passes backwards along the lower border of the pons, superficial to the sixth, seventh, and eighth nerves, to the anterior part of the under surface of the cerebellar hemisphere where it is distributed. It anastomoses with the posterior inferior cerebellar artery (4) The **superior cerebellar artery** arises near the bifurcation of the basilar artery It is a large vessel and runs laterally and backwards along the upper border of the pons behind the oculo-motor nerve and then winds round the cerebral peduncle to reach the upper surface of the cerebellum. It divides there into a large number of branches which spread out ver the cerebellum and at its margins anastomose with the branches of the inferior cerebellar arteries. (5) The **posterior cerebral arteries**.

The course and distribution of the branches of the posterior middle and anterior cerebral arteries are to be studied with care for they are liable to pathological changes the diagnoses of which depend on a knowledge of the areas they supply The cerebral branches of the carotid system are prone to weakness of the musculo-elastic coat of

takes the place of the perivascular lymph vessels in other tissues. The cortical arteries are well seen as fine filaments if a piece of pia mater is very carefully raised from the surface of the hemisphere. They supply the grey cortex of the cerebrum and the sub-cortical white matter and it should be noted, since they anastomose freely in the pia mater the blood supply of neighbouring areas of the cortex

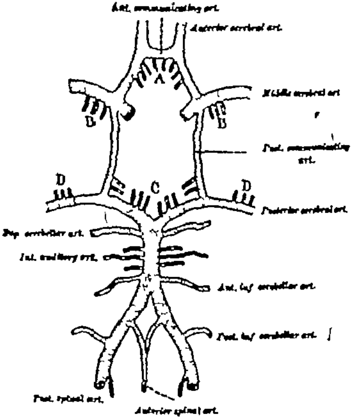


FIG. 110.

The arrangement of the arteries on the base of the brain and the formation of the circulus arteriosus. A. Antero-medial, B. antero-lateral, C. postero-medial, and D postero-lateral central arteries.

is not sharply demarcated. The cerebral hemispheres have also distributed to them a second system of branches named the central or basal branches. They are slender arteries, less than 1 mm. in diameter which arise in groups from the cerebral arteries and the circulus arteriosus and pierce the base of the brain especially at the anterior and posterior perforated spaces they supply the central parts of the brain. They differ from the cortical branches in that they

posterior part of the lateral surface of the occipital region (calcarine and parieto-occipital arteries). These vessels run in th fissures from which they are named, and it should be noted that the calcarine branch supplies the visual area of the cerebral cortex.

2. The central branches (Fig. 110) form two groups. The postero-medial vessels arise on the base of the brain and pierce the posterior perforated space. They supply the posterior part of the thalamus and the medial parts of the cerebral peduncle. The postero-lateral branches arise on the lateral side of the peduncle and supply the corpora quadragemina, the geniculate bodies, the pineal gland, and the posterior part of the thalamus.

3. The posterior choroidal arteries are a set of small branches which enter the velum interpositum and end in the choroid plexuses of the lateral and third ventricles.

The anterior cerebral artery is the smaller of the terminal branches of the internal carotid artery. It runs forwards, as already described, to the anterior part of the great longitudinal fissure and is joined in this part of its course to the opposite vessel by the anterior communicating artery. It then turns round the anterior end of the corpus callosum and is continued backwards close to its upper surface on the medial surface of the hemisphere as far as the parieto-occipital fissure. Its branches are as follows:—

1. Cortical branches (Fig. 111) are distributed to the medial part of the under surface of the frontal region (orbital branches) and the medial surface of the hemisphere as far back as the parieto-occipital fissure (anterior and posterior medial frontal branches). These branches turn round the upper margin of the hemisphere and supply a strip nearly an inch wide of the adjacent part of the lateral surface.

2. The central branches (Fig. 110) form the antero-medial group which pass into the base of the brain in front of the optic chiasma. They supply the anterior part of the corpus callosum, the head of the caudate nucleus, and the anterior parts of the lentiform nucleus and the internal capsule.

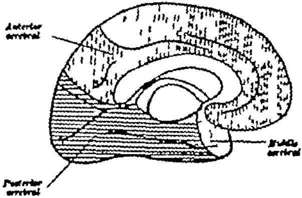
The middle cerebral artery, the larger of the two terminal branches of the internal carotid artery and the more direct continuation of it, passes laterally into the stem of the lateral (Sylvian) fissure. Remaining in the depth of the fissure it passes t the lateral surface of the hemisphere and reaches the surface of the insula (island of Reil) where it divides into a number of branches. These branches emerge between the lips of the lateral fissure and spreading out ver the hemisphere supply the greater part of the lateral surface, the lateral part of the orbital surface, and the temporal pole (Fig. 111). The branches of distribution are:—

1. The cortical branches supply the lateral surface of the frontal, parietal, and temporal regions (frontal, parietal, and temporal arteries), and near the margins of the hemisphere anastomose with the branches of the anterior and posterior cerebral arteries. They also supply the lateral part of the orbital surface (lateral orbital arteries) and the temporal pole (anterior temporal arteries).

2. The central branches (Fig. 110) are the antero-lateral central arteries. They arise on the base of the brain close to the ant rior perforated space and enter the openings in t. They are grouped in two sets, known as the medial and the lateral striat arteries. The medial striate arteries pass upwards through the medial parts of the lentiform nucleus and the internal capsule

their wall particularly at the places of division and aneurysmal dilatations which readily rupture are often to be found on them. The course of the arteries is to be followed on the bisected brain as they are exposed in the di section

The **posterior cerebral arteries** are the terminal branches of the basilar artery Each artery runs laterally and backwards parallel to the superior



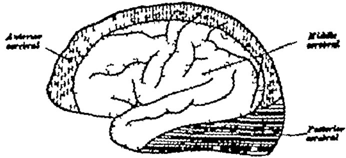


FIG 111

Diagrams to show the areas of distribution of the cortical arteries of the cerebral hemisphere the pper figure show the medial and inferior surfaces and the lower figure the lateral surface

cerebellar artery rom which t is separated by the oculo-motor nerve and curving round the cerebral peduncle reaches the under surface of the cerebral hemisphere. It distributes large number of branches there and is continued backwards beneath the posterior end of the corpus callosum; there it sinks into the calcarine fissure nd divides into its terminal branches. Its branches are as follow —

1 The **cortical branches** (Fig 111) are distributed t the under surface of the temporal region xcept the area of the temporal pole (anterior and posterior temporal arteries), and the medial and under surfaces and the

cavernous, superior petrosal, and transverse sinuses on the base of the skull. There are very constant members of this group in the lateral fissure (middle cerebral vein) and accompanying the anterior cerebral artery (anterior cerebral vein). They join with one another on the base of the brain close to the *anterior perforated space* to form the basal vein which passes backwards and round the cerebral peduncle to terminate in the great cerebral vein (see p. 321); the basal vein also receives the striate veins which issue through the anterior perforated space from the striate nuclei.

The membranes and blood vessels are now to be removed from the brain and its surface cleanly exposed, care again being exercised to preserve the cranial nerves which are attached to the base. It is advisable to leave the membranes on the medulla and the under surface of the cerebellum on account of their relation to the roof of the fourth ventricle which is otherwise certain to be damaged.

The several parts of the brain are now to be studied in detail. The cerebral hemispheres are to be examined first and that all of their surface may be exposed the mid brain is to be cut through on one half of the sectioned brain the pons, medulla and cerebellum will thus be separated from the cerebral hemisphere.

The Cerebral Hemispheres

The cerebral hemispheres almost separated from one another by the great longitudinal fissure form the cerebrum, by far the largest part of the brain. They develop as lateral outgrowths of the fore-brain, the cavities in their interior being the lateral ventricles. They are composed of (1) a covering layer of grey matter the **cerebral cortex**, which varies from 2·5 to 4 mm. in thickness in different areas (2) a central mass of white matter which surrounds the ventricle and consists of nerve fibres some of which connect different areas of the cortex together and some pass to it from other parts of the brain and from it to them and (3) a mass of grey matter the **corpus striatum**, which is embedded in the white matter on the lateral *side* of the ventricle (Fig. 128)

The highest *functions* of the nervous system take place in the cerebral cortex, so that there are in it for example areas which are motor centres for the initiation of voluntary movement, areas which are sensory centres for the conscious perception of smell, vision, and hearing and areas which are related to the *processes of attention* and judgment. The amount of the cortex is increased by its being folded. The folding begins in the fourth month of foetal life and advances rapidly over the whole surface it is caused by the differential and unequal growth of different functional areas. The surface of the mature hemispheres is thus characterised by a complex pattern of **convolutions** or **gyri**, which are areas of growth separated by intervening **fissures** or **sulci** which are ungrown intervals between areas of growth The main features of the pattern are constant in all normal brains, that is, the same areas serve the same functions, but

and end in the caudate nucleus. They supply the anterior parts of the two nuclei and the anterior part of the internal capsule. The lateral striate arteries pass upwards through the lateral part of the lenticular nucleus, or through the external capsule and bend medially through the lentiform nucleus to the internal capsule and caudate nucleus. They are arranged in anterior and posterior groups. The anterior arteries lie in a definite row; and one of them, larger than its companions and the most frequent seat of rupture of all the cerebral arteries, has been named the artery of cerebral hæmorrhage (the artery of Charcot).

3 The anterior choroidal artery is a small branch which usually arises from the internal carotid artery close to its termination. It passes backwards to the lower part of the choroidal fissure of the cerebral hemisphere and terminates in the choroid plexus of the inferior horn of the lateral ventricle.

The veins of the brain are arranged in two sets namely the **superficial veins** which lie on its surface in the pia mater and the sub-arachnoid space and the **deep veins** which issue from its substance. The terminal trunks of both sets of veins, or the trunks formed by the junction of the deep with the superficial veins pierce the arachnoid and the cerebral layer of the dura mater and end in the cranial venous sinuses. The cerebral veins do not possess valves they are also characterised by their very thin walls which are almost devoid of muscle fibres. It is not usual to make a detailed dissection of them but the following main facts of their arrangement should be studied —

The deep veins of the medulla issue from its substance and end in the superficial veins. These veins form a plexus on the surface of the medulla in which an anterior and a posterior median trunk are the main vessels; the plexus communicates with the veins of the spinal cord below and is drained by small lateral veins which run with the roots of the last four cranial nerves and end in the inferior petrosal sinus or in the bulb of the internal jugular vein.

The deep veins of the pons issue on its anterior surface where they join the plexus of the superficial veins. These veins drain into the basal vein (see below) or enter the inferior petrosal sinus.

The deep veins of the cerebellum terminate in the superficial veins. These veins lie on the upper and lower surfaces of the cerebellum separately from the arteries. They end in upper and lower median vessels which join the great cerebral vein (see p 331) or the straight sinus and in lateral vessels which pass to the transverse and petrosal sinuses

The deep veins of the cerebral hemisphere will be examined during the dissection of the brain The superficial veins are of large size and are more numerous than the arteries They form two sets, the superior and the inferior superficial cerebral veins; the two sets anastomose freely with one another (1) The superior veins, eight to twelve in number lie on the upper and lateral parts of the hemisphere and run upwards towards the superior sagittal sinus in which they terminate; they follow the fissures of the hemisphere to the mouths of which most of them lie It has already been observed that the posterior veins of this set run obliquely forwards for some distance in the wall of the sinus and that their orifices are directed forwards against the blood stream. (2) The inferior veins lie on the lateral and inferior surfaces of the hemisphere and terminate in the spheno-parietal,

which forms the floor of the fossa is moulded into convolutions like the other parts of the surface of the hemisphere; it is named the insula or island of Reil.

The insula is to be exposed as much as possible on one hemisphere by widely separating the lips of the lateral fissure. It will be seen to be triangular in outline and to be bounded by a limiting sulcus, the sulcus circularis insulae

The sulcus circularis consists of three parts, an upper horizontal part from the ends of which a vertical part descends in front, and an inferior oblique part runs downwards and forwards behind. The insula is thus marked off from the neighbouring regions of the hemisphere except at its antero-inferior apical part where the sulcus circularis is deficient This non-bounded part of the insula (the limen insulae) lies close to the anterior perforated space on the base of the brain and a convolution of it is continuous with the piriform area of the hippocampal convolution, as will be described later The surface of the insula is divided by an oblique fissure (sulcus centralis insulae) into two parts, anterior and posterior each of which is usually subdivided into smaller gyri by secondary sulci.

The parts of the hemisphere which overlap the insula are named the insular opercula, and they form, by the apposition of their margins, the three branches of the lateral fissure. The opercula are four in number and are easily distinguished (Fig 112)

The temporal operculum extends upwards over the insula from the temporal region. Its upper margin forms the lower lip of the posterior ramus of the lateral fissure The fronto-parietal operculum covers the insula from above, extending downwards from the frontal and parietal regions to meet the temporal operculum The frontal operculum is the small triangular field which intervenes between the ascending ramus and the anterior horizontal ramus of the lateral fissure. It is sometimes named the pars triangularis. The orbital operculum lies below the anterior horizontal ramus of the lateral fissure and, for the most part, is on the under surface of the hemisphere. It projects backwards over the anterior part of the insula from the orbital area of the frontal region.

The central fissure (of Rolando) is the second fissure to be examined (Fig 112) It lies on the lateral surface of the hemisphere, across which it takes an oblique course downwards and forwards and intervenes between the frontal region in front and the parietal region behind. The upper end of the fissure cuts the upper border of the hemisphere a short distance (half an inch) behind the mid point between the frontal and occipital poles, and as a rule it is carried a little way downwards on the medial surface (Fig 113) Its lower end terminates a little above the middle of the posterior branch of the lateral fissure.

The central fissure (of Rolando) (Fig 112) forms n angle of about 70° (approximately three-quarters of a right angle) with the upper border of the hemisphere; and it may be mapped on the scalp by drawing a line three and a half inches long downwards and forwards at this angle from a point

the details differ in different brains. It is thus possible to recognise certain fissures as the main or primary fissures of the hemispheres: they appear early in development and they intervene between the main or primary areas of the cortex. They are used therefore to subdivide the surface of the cerebral hemispheres into primary regions which in a general way are associated with particular functions. The primary regions are subdivided into secondary regions and they into tertiary regions by secondary and tertiary fissures: these fissures appear later in development, they are less constant in form, and they intervene between more specialised and later differentiated functional areas. The majority of the fissures are thus the boundaries between cortical areas which are different in function, and which are also different in thickness and structure; but there are some fissures in areas of uniform structure, and in some single convolutions there are areas of different structure unseparated by fissures.

The **primary fissures** of the cerebral hemisphere are the rhinal, lateral, central, parieto-occipital, circular, collateral, callosal and cingulate fissures; and the **primary regions** are the olfactory, frontal, parietal, temporal, occipital, insular and limbic regions: an examination is to be made of them on the four hemispheres that are available. It is convenient to begin with the **lateral** or **Sylvian fissure** and the areas related to it.

The **lateral fissure** (*of Sylvius*) is the most conspicuous fissure on the surface of the cerebral hemisphere. It is composed of a short main stem which lies on the base of the brain and a series of **branches** on the lateral surface. The stem begins lateral to the anterior perforated space and runs almost transversely laterally as a deep furrow between the orbital surface of the frontal region in front and the pole of the temporal region behind. The stem reaches the lateral surface of the hemisphere at the Sylvian point, half an inch behind the temporal pole, and there, under the pterion of the skull, the fissure divides into three (sometimes only two) branches (Fig. 112). (1) The **posterior ramus**, the longest and most constant, extends backwards and slightly upwards on the lateral surface of the hemisphere for a distance of nearly three inches. It intervenes between the temporal region which lies below it and the frontal and parietal regions which lie above it; and it ends by turning upwards into the parietal region in the form of an ascending terminal part. (2) The **anterior horizontal ramus** runs almost horizontally forwards into the frontal region for a distance of about one-half or three-quarters of an inch. (3) The **anterior ascending ramus**, which is inconstant, proceeds upward and slightly forwards into the lower part of the frontal region for a distance of about an inch.

The two anterior rami of the lateral fissure are most commonly independent of one another [illegible] the U or V form [illegible] described [illegible] and shown in Fig. 11[illegible], but almost as frequently they arise by a common stem from the main fissure (Y form), or are represented by a single limb (I form).

The lateral fissure is formed by the coming together of the rapidly growing edges of large [illegible] on the lateral surface of the hemisphere, which itself does not grow [illegible]. If the lips of the posterior ramus of the fissure are separated, the [illegible] the [illegible] be [illegible] like folds (opercula), which cover the fossa and hide it from surface view (Fig. 123). The area of cortex

which forms the floor of the fossa is moulded into convolutions like the other parts of the surface of the hemisphere; it is named the insula or island of Reil.

The insula is to be exposed as much as possible on one hemisphere by widely separating the lips of the lateral fissure. It will be seen to be triangular in outline and to be bounded by a limiting sulcus, the **sulcus circularis insulæ.**

The sulcus circularis consists of three parts, an upper horizontal part from the ends of which a vertical part descends in front, and an inferior oblique part runs downwards and forwards behind. The insula is thus marked off from the neighbouring regions of the hemisphere except at its antero-inferior apical part where the sulcus circularis is deficient. This non bounded part of the insula (the limen insulæ) lies close to the anterior perforated space on the base of the brain and a convolution of it is continuous with the piriform area of the hippocampal convolution, as will be described later. The surface of the insula is divided by an oblique fissure (sulcus centralis insulæ) into two parts, anterior and posterior each of which is usually subdivided into smaller gyri by secondary sulci.

The parts of the hemisphere which overlap the insula are named the insular **opercula**, and they form, by the apposition of their margins the three branches of the lateral fissure. The opercula are four in number and are easily distinguished (Fig. 112)

The temporal operculum extends upwards over the insula from the temporal region. Its upper margin forms the lower lip of the posterior ramus of the lateral fissure. The fronto-parietal operculum covers the insula from above, extending downwards from the frontal and parietal regions to meet the temporal operculum. The frontal operculum is the small triangular field which intervenes between the ascending ramus and the anterior horizontal ramus of the lateral fissure. It is sometimes named the pars triangularis. The orbital operculum lies below the anterior horizontal ramus of the lateral fissure and, for the most part, is on the under surface of the hemisphere. It projects backwards over the anterior part of the insula from the orbital area of the frontal region.

The **central fissure** (of Rolando) is the second fissure to be examined (Fig 112) It lies on the lateral surface of the hemisphere, across which it takes an oblique course downwards and forwards and intervenes between the frontal region in front and the parietal region behind. The upper end of the fissure cuts the upper border of the hemisphere a short distance (half an inch) behind the mid point between the frontal and occipital poles, and as a rule it is carried a little way downwards on the medial surface (Fig 113) Its lower end terminates a little above the middle of the posterior branch of the lateral fissure

The central fissure (of Rolando) (Fig 112) forms an angle of about 70° (approximately three-quarters of a right angle) with the upper border of the hemisphere and it may be mapped on the scalp by drawing a line three and a half inches long downwards and forwards at this angle from a point

half an inch behind the mid point between the glabella and the external occipital protuberance (Fig 70). While the general direction of the fissure may be thus indicated, it is far from being straight. Its course across the hemisphere is sinuous. Near its upper end there is usually a bend backwards; the upper and lower limits of the curved part are commonly named the upper and the lower genu If the fissure is widely opened, it will often be seen that the continuity of its upper part is interrupted by a sunken connexion between its anterior and posterior walls: this is named a deep annectant gyrus.

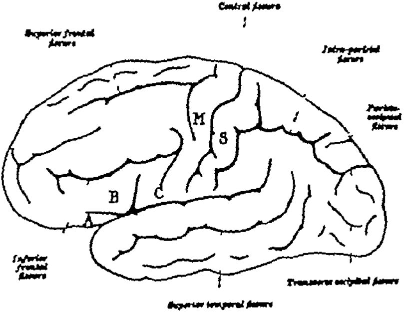


FIG. 112.

A diagram of the lateral surface of the cerebral hemisphere and the main fissures on it the student is to name the convolutions related to them. A. Pars orbitalis, B. pars triangularis, and C. pars basalis of the inferior frontal convolution; M pre-central convolution; S. post-central convolution.

The frontal region, so far as it may be limited, lies in front of the central (Rolandic) fissure on the lateral surface of the hemisphere and in front of the stem of the lateral (Sylvian) fissure on the under surface There is also a part of it on the medial surface of the hemisphere which extends to the sulcus cinguli (Fig. 113) A series of fissures, which vary in their form and arrangement, break up these surfaces. On the orbital surface (Fig 112) there are two fissures, the olfactory sulcus which lodges the olfactory bulb and tract and, lateral to it, the orbital sulcus which assumes many different forms.

The olfactory sulcus is a straight deep furrow which lies parallel to the medial border of the hemisphere. The narrow strip which lies on its medial

side is named th gyrus rectus. The orbital sulcus is a compound fissure of variable form, but most commonly it is H-shaped. It subdivides the lateral part of the orbital surface into a number of small orbital gyri. The orbital surface as a whole is concave and, facing downwards and laterally rests on the roof of the orbit and the roof of the nose. The orbital fissures on it fit into ridges on the orbital plate of the frontal bone.

On the **lateral surface** of the frontal region the **pre-central** (anterior central, pre-Rolandic) **convolution** is to be identified (Fig 112) It is the long continuous gyrus which lies immediately in front of the central fissure and is limited anteriorly by the **superior** and **inferior pre-central fissures**. It is to be carefully examined and its relations to the surface of the head are to be considered, for it includes the **motor area** of the cerebral cortex. In front of the pre-central convolution is the pre-frontal region it is divided into three horizontal parts, the **superior middle**, and **inferior frontal convolutions**, by the **superior** and **inferior frontal fissures** (Fig 112)

The **superior pre-central fissure** is a short vertical fissure which lies in front of the upper part of the central fissure. Almost invariably the superior frontal fissure runs horizontally forwards from it, and occasionally it is continuous with the inferior pre-central fissure. The **inferior pre-central fissure** consists of a vertical part which lies in front of the lower part of the central fissure and an oblique part which runs upwards and forwards from it. Not infrequently one or other of these parts is confluent with the **inferior frontal fissure** which runs more or less horizontally forwards to the margin of the hemisphere close to which it ends in a terminal bifurcation.

The pre-central convolution and the adjoining posterior parts of the superior middle, and inferior frontal convolutions form what is known as the **pre-central area** it is the area in which the voluntary movements of the opposite side of the body arise. It consists of two parts, namely (1) the **motor area** proper which is confined to the posterior part of the pre-central convolution, and (2) the **pre-motor area** which extends forwards from it and across the pre-central fissures into the frontal convolutions.

The **motor area** (Fig 112) gives origin to the cerebro-spinal (pyramidal) tract which passes downwards through the lower parts of the brain and the whole length of the spinal cord and ends round the motor cells which giv origin to the motor nerves of the opposite sid of the body; and it carries to them the impulses which initiate the voluntary movements, such as, for example, flexion of the hip joint, extension of the fingers, and protrusion of the tongue. It has been found by experiment that the upper end of the motor area, which extends on to the adjoining para-central area on the medial surface of the hemisphere, controls the movements of the perineum and the lower limb and therefore there are placed there what are called the motor centres for these parts; and below them, in the order given, are the motor centres for the trunk, the upper limb the neck, and the face.

The motor area is represented on the surface of the head by a strip a quarter of an inch wide in front of the line of the central fissure (p. 301 and Fig 79). It lies, therefore, behind the coronal suture. The superior temporal line crosses it at the lower part of the arm area so that the face centres are covered by the temporal muscle; in the child, however the

temporal muscle is much smaller in size and the whole motor area is exposed above it

The pre-motor area controls the combinations of voluntary movements which constitute voluntary acts, each act being a series of movements carried out in a proper sequence and in a proper amount. The details of the representation of these acts on the cortex are not yet known, but immediately in front of the arm area there is in the middle frontal convolution an area for the control of the conjugate movements of the eyes and the associated movements of the head (see p. 203), and in the inferior frontal convolution, in front of the face area, there is the motor centre for speech; the speech centre however is developed only on one hemisphere, the left hemisphere in right handed people

The inferior frontal convolution is intersected by the anterior branches of the lateral fissure which subdivide its lower area into three parts. The pars orbitalis lies below the anterior horizontal ramus, the pars triangularis is included between the anterior and ascending rami, while the pars basalis is the part between the ascending ramus of the lateral fissure and the vertical part of the pre-central fissure (Fig 112); it is traversed by a shallow fissure the sulcus diagonalis. The pars triangularis and that part of the pars basilaris in front of the sulcus diagonalis, that is the convolution which is moulded round the ascending limb of the lateral fissure, is often named the *convolution of Broca.*

The **medial surface** of the frontal region (Fig. 113) consists of a large peripheral convolution which is continuous with the superior frontal gyrus over the margin of the hemisphere It is limited below and separated from the gyrus cinguli by the **sulcus cinguli.**

The sulcus cinguli (calloso-marginal fissure) is a deep fissure on the medial surface of the hemisphere. It commences below the genu of the corpus callosum and curving parallel to that body it runs at first upwards below it and then backwards above it. It ends by turning upwards and cutting the superior margin of the hemisphere a little way behind the central fissure. Almost constantly a branch of the sulcus runs upwards in front of the central fissure and the part of the frontal region which lies between it and the terminal part of the sulcus is named the **para-central convolution.** The central fissure partially divides it into two parts, the anterior of which is part of the pre-central motor area and the posterior part of the post-central sensory area (Fig 113).

The lateral surface of the **parietal region** lies behind the central fissure and above the posterior limb of the lateral fissure (Fig 11). On it there should be identified first the **post-central** (post Rolandic) **convolution**, which lies immediately behind the central (Rolandic) fissure and is limited posteriorly by the **superior and inferior post central fissures.** This convolution includes within it an anterior and a posterior area the anterior area receives the terminal parts of the sensory paths of all common sensations which there rise into consciousness, and the posterior part relates them with past experience and so gives them a conceptual value. The anterior area is thus known as the **area of common sensation** and the posterior area as the

psycho-sensory area. The remainder of the parietal surface is divided into superior and inferior parietal convolutions by the intra-parietal fissure, a horizontally running sulcus which begins in the inferior post-central fissure.

The superior and inferior post-central fissures lie behind the upper and lower parts of the central fissure and may or may not be continuous with one another; they form the posterior boundary of the post-central convolution. From the upper end of the inferior fissure the ramus parietalis of the intra-parietal fissure extends backwards and slightly upwards, and may be continued into the ramus occipitalis. More frequently however the latter is a separate fissure which runs backwards and downwards into the occipital region where it ends in a transverse fissure the sulcus occipitalis transversus (Fig 113)

The superior parietal convolution lies above the intra parietal fissure and the inferior parietal convolution below it. The latter area comprises three arched gyri. The anterior of them, the supra-marginal gyrus, is bent round the upturned end of the lateral fissure; the middle, named the angular gyrus, surrounds a fissure which is sometimes confluent with the superior temporal fissure; and posterior t it and separated from it by a transverse sulcus there is the post-parietal gyrus.

The occipital region of the hemisphere is separated from the parietal region by the deep parieto-occipital fissure, the main part of which is on the medial surface The fissure runs downwards and forwards and joins the post-calcarine fissure a short distance behind the splenium of the corpus callosum and from their junction the calcarine fissure passes forwards below the splenium. These fissures thus form a ≺-shaped figure (Fig 113) The triangular area which lies between them is named the cuneus, the area above it is the precuneus, and the area below it the gyrus lingualis.

The parieto-occipital fissure (Fig 113) is a deep cleft which lies almost vertically on the medial surface of the hinder part of the hemisphere Its upper end cuts the superior border of the hemisphere about two inches above the occipital pole, and is continued on the lateral surface for about half an inch the lower end of the fissure joins the post-calcarine fissure. If it is widely opened up, however it will be seen that the junction is only superficial, for a deep annectant gyrus will be exposed which crosses between the walls of the parieto-occipital fissure and separates it from the post-calcarine fissure.

The post-calcarine fissure commences in the neighbourhood of the occipital pole very frequently as a bifurcated fissure; this part is most often on the medial surface but sometimes it is on the lateral surface of the hemisphere. The fissure runs forwards a little above the lower margin of the hemisphere and superficially joins the parieto-occipital fissure behind the splenium of the corpus callosum. Here also the post-calcarine fissure is superficially continuous with the calcarine fissure but the two fissures are separated by a cuneo-lingual annectant gyrus, as will be seen if they are opened. The calcarine fissure crosses the lower margin of the hemisphere and passes forwards on its inferior surface; it ends below the splenium of the corpus

The collateral fissure does not reach the margin of the temporal pole but sometimes becomes confluent with a shallow sulcus which separates the anterior end of the hippocampal convolution from the temporal pole this sulcus is the rhinal fissure (Fig 113).

The **gyrus lingualis** lies between the calcarine and collateral fissures. It commences at the occipital pole and runs forwards into the hippocampal gyrus. It lies partly on the medial and partly on the tentorial surface of the hemisphere.

The cortex of the occipital region is the centre for sight. Two areas are recognised in it, the visuo-sensory or striate area and the visuo-psychic area.

The **visuo-sensory area** (area striata) is the cortical receiving centre for visual impressions and in it the size form, colour and movement of objects seen are recognised in consciousness the identification of the objects seen, however takes place in the visuo-psychic area. The visuo-sensory area occupies (1) the upper and lower walls of the post-calcarine fissure and the adjoining parts of the cuneus above and lingual gyrus below and (2) the lower wall of the calcarine fissure and the adjoining part of the lingual gyrus below The area may or may not extend beyond the occipital pole onto the lateral surface of the hemisphere when it reaches the lateral surface it is limited in front by the sulcus lunatus The **visuo-psychic area** surrounds the visuo-sensory area extending downwards to the collateral fissure and upwards to the parieto-occipital fissure, and, on the lateral surface forwards to the transverse occipital fissure.

The **temporal region** of the hemisphere is that part which lies behind the stem of the lateral fissure its anterior end forms the temporal pole. On the lateral surface of the hemisphere it is limited above by the posterior branch of the lateral fissure while on the under surface it extends medially to the collateral fissure. On the **lateral surface** there is to be identified the **superior temporal fissure**, a deep cleft which begins near the temporal pole in front and runs backwards parallel to the posterior branch of the lateral fissure. It ends by turning upwards into the parietal region where it is surmounted by the gyrus angularis (Fig 112) Below the superior fissure the surface of the temporal region is interrupted by an irregular series of fissures one behind the other which are classified together as the **inferior temporal fissure** they lie midway between the superior fissure and the lower margin of the hemisphere. The most posterior of the series turns upwards into the parietal region and intervenes between the angular gyrus in front and the post parietal gyrus behind.

The lateral surface of the temporal region is divided by the two fissures into three horizontal convolutions the **superior middle, and inferior temporal gyri** The superior gyrus is continuous with the gyri which are present on the deep surface of the temporal operculum they are to be exposed by widely opening the lateral fissure They are three or four in number and run obliquely forwards from the postero-inferior limb of the sulcus circularis insulae. They are known as the

transverse temporal gyri, and in the most anterior of them (the gyrus of Heschl) and in the adjoining part of the superior temporal gyrus is the cortical centre for hearing.

The audito-sensory area, the cortical centre for hearing, lies in the gyrus of Heschl and a limited area of the adjoining part of the superior temporal convolution. In it auditory stimuli become conscious as sounds, and their intensity, rhythm, and quality can be differentiated. The origin and meaning of the sound, however, are determined in the audito-psychic area; this area comprises the remainder of the superior temporal convolution. The middle and inferior temporal convolutions have also audito-psychic functions, and though their nature is not yet certain it is probable that they have to do with the interpretation of speech.

The **inferior surface** of the temporal region lies on the lateral part of the middle cranial fossa and behind it, on the tentorium cerebelli. *Its inferior relations*, therefore, include the semilunar ganglion, the carotid canal and the tegmen tympani of the middle ear. It is thus liable to become involved in the intra-cranial spread of middle-ear disease. There are on it, near the margin of the hemisphere, a variable number of furrows lying parallel to the collateral fissure. They are grouped together as the **occipito-temporal fissure**, and serve to subdivide this area of the temporal region into a lateral part which is continuous with the inferior temporal gyrus, and a medial part, limited by the collateral fissure, which is named the **gyrus fusiformis** (Fig. 113).

The **hippocampal gyrus** is the most medial convolution on the tentorial surface of the hemisphere (Fig. 113). Posteriorly, under the splenium of the corpus callosum, the calcarine fissure cuts into it and divides it into two parts: the lower part is continuous with the gyrus lingualis, and the upper part with the gyrus cinguli. The hippocampal gyrus and the gyrus cinguli are sometimes classed together as the **gyrus fornicatus**.

It has already been described that the **olfactory nerves** enter the under surface of the **olfactory bulb**. They terminate in the bulb, and it remains now to examine the connexions which are formed by the olfactory bulb through the **olfactory tract** which issues from its posterior end. These connexions are concerned with the reception and interpretation of olfactory stimuli, and together with the olfactory bulb and tract which convey the stimuli to them, and the fornix which is an efferent tract from them, they constitute the **rhinencephalon** or smell brain. The parts of the rhinencephalon are small and rudimentary in the human brain, and at the present stage of the dissection some of them cannot be seen [illegible]; however, the student should follow the description given below.

The olfactory bulb (Fig. 100) is a small flattened mass of grey matter which lies in the sulcus olfactorius on the under surface of the frontal region of the hemisphere. When the brain is in position the olfactory bulb rests on the cribriform plate of the [illegible] bone and receives the olfactory nerves

on its under surface. The olfactory nerves end in it. Its cells give origin to the olfactory tract, a narrow prismatic band of white matter which issues from its posterior end and runs backwards in the sulcus olfactorius. At the anterior end of the anterior perforated space the olfactory tract broadens and then appears to divide into two main roots which diverge from one another.

At the point of divergence there are a small ovoid area of grey matter, the olfactory pyramid, and immediately postero-lateral to it a small eminence of grey matter, the olfactory tubercle, but as a rule they cannot be distinguished from the anterior perforated space. They and the grey matter of the anterior perforated space receive some of the fibres of the olfactory tract which end in them, and they give origin to fibres which convey the received olfactory stimuli to the hippocampal formation, the cortical centre for smell. The lateral root of the olfactory tract, which is a continuation backwards of the olfactory tract, passes almost transversely laterally across the anterior perforated space to the limen insulæ and bending sharply backwards ultimately ends in the anterior end of the hippocampal convolution. This part of the hippocampal gyrus is known as the uncus (area pirliformis) (Fig. 113); it is limited laterally by the rhinal fissure and forms the recurved hook-like extremity of the gyrus. The fibres of the olfactory tract conveyed to the uncus by the lateral root of the tract end in it, and it gives rise to fibres which pass to the hippocampal formation.

The hippocampal formation will be examined later.

The surface of the cerebral hemisphere having been examined, a study of the structure of the interior is to be commenced. The undivided brain is to be used in this dissection. It is to be placed base downwards and the right hemisphere cut through horizontally at about the level of the cingulate fissure with a large brain knife. On the section the cerebral hemisphere is seen to be composed of a central mass of white matter and a narrow folded coating of grey matter, the cerebral cortex. The white matter is named the **medullary centre**; it is studded with divided blood vessels. It consists of medullated nerve fibres which may be classified in three groups according to the connexions they establish. The groups are: (1) **Association fibres**, which constitute the bulk of the white matter, link together different parts of the cortex of the same hemisphere; (2) **commissural fibres** connect areas of the cortex of one hemisphere to corresponding areas of the cortex of the opposite hemisphere; and (3) **projection** or **itinerant fibres** connect the cerebral cortex with other parts of the central nervous system, for example, the thalamus, the pons, or the spinal cord.

The association fibres are of two kinds. The short association fibres connect adjacent gyri. They lie immediately beneath the cortex or even in its deepest layer, and through them the cortex is made a functional whole. They vary in number in different brains and there is good evidence that they increase in number with the mental development of the subject. The long association fibres are more primitive in kind and develop at an earlier time. They connect more widely separated areas of the brain and group themselves in indistinct bundles which can be isolated in formalin hardened brains after the cortex and short association fibres are removed. Diagrams of the chief bundles are given in the text-book, but only one of them, the cingulum, is to be dissected.

The substance of the right hemisphere is to be removed down to the level of the upper surface of the corpus callosum. This is to be done by scraping with a blunt knife or by gently tearing away the brain matter in a lateral direction If the dissection is being performed for the first time it is advisable to have the assistance of a demonstrator *As the white substance of the gyrus cinguli is being removed an attempt should be made to define a distinct longitudinal band which is embedded in it* this is the cingulum.

The cingulum is a band of white fibres which is embedded in the white centre of the gyrus cinguli but can be isolated from it. It begins in front in the region of the anterior perforated space, and curves round the anterior end and over the upper surface and round the posterior end of the corpus callosum, and ends in the hippocampal gyrus. The cingulum is a long association bundle, *the easiest of the series to dissect*; *it is formed by several systems of fibres* which begin and end in the adjacent grey matter and run only short distances within it.

The cerebral cortex will be seen to be spread in a continuous layer over the entire surface of the hemisphere, though it is not of equal thickness in all localities it varies from 1 25 mm. in the occipital region to 4 mm. in the pre-central convolution, and over the top of a convolution it is usually thicker than at the bottom of a fissure. *The structure of the cortex cannot be studied in the dissecting-room, but* it is to be stated that there are differences in structure in areas of different function about one hundred different areas have been distinguished. One of the areas, the visual centre (p. 307) is so characteristic in its naked-eye appearance that it should be examined by making a vertical section through the occipital pole. The cortex round the post-calcarine fissure will then be seen to have in it, parallel to the surface a white band which is named the stria of Gennari and it is to be understood that this is a characteristic of the area of the cerebral cortex which is associated with the reception of sight impressions.

The dissection which has been carried out on the right hemisphere *is to be repeated on the left side so that the whole upper surface of* the corpus callosum is exposed. *It will now be seen that the corpus* callosum is f rmed by a mass of commissural fibres uniting the two hemispheres It is to be studied at the same time on the medial face of the sectioned brain.

The corpus callosum is the commissural tract of the cerebral hemispheres, being formed of tran verse fibres which connect all the areas of the cortices of the two sides except the hippocampal (rhinencephalon) formations. As seen on medial section (Fig 107), t is arched from before backwards, and is placed a little nearer the anterior than the posterior end of the brain. It unites the hemispheres for about half their length. The posterior end, full and rounded, is named the splenium; it is the thickest part of the corpus callosum. The intermediat part named the body is much thinner The anterior end which is bent down ards nd backwards on itself is called the genu. The part hich extends downwards and backwards from the genu is

the rostrum; it thins rapidly and ends as a fine band of neuroglial tissue which fuses with the lamina terminalis just above the anterior commissure.

The upper surface of the corpus callosum (Fig. 114) is about an inch wide. It forms the bottom of the great longitudinal fissure and at the sides is covered by the cingulate gyri. It is coated with a very thin layer of grey matter in which there are two longitudinal bands of fibres, the striae longitudinales medialis and lateralis, on each side of the middle line. The medial stria is the more distinct; it is close to the middle line and is separated from that of the opposite side only by a faint groove. The grey lamina with the striae which represent its white matter is the indusium griseum or gyrus supracallosus; it is a part of the hippocampal formation. It is prolonged round the splenium of the corpus callosum into the dentate gyrus and round the genu as the paraterminal gyrus or gyrus subcallosus; this is the narrow area of grey matter in front of the lamina terminalis which, as a faint ridge, descends towards the

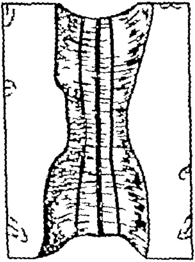


Fig. 114

The upper surface of the corpus callosum and the striae longitudinales.

anterior perforated space. These further parts also belong to the hippocampal formation; the medial root of the olfactory tract is now to be traced to the anterior of them.

The transverse fibres of the corpus callosum are easily seen through the coating of grey matter. As they enter the white substance of the hemisphere they spread out so as to reach most parts of the cerebral cortex. The most anterior fibres, which pass through the genu, curve forwards into the frontal region; they form a curved band known as the forceps minor. The most posterior fibres, which pass through the splenium, bend abruptly backwards into the occipital region; they form a bundle named the forceps major. The intermediate fibres are transverse and those which pass through the posterior part of the body form a compact stratum called the tapetum, which roofs the posterior horn of the lateral ventricle and bending downwards forms its lateral wall and the lateral wall of the inferior horn (Fig. 118).

The relations of the under surface of the corpus callosum to the lateral ventricle, the septum lucidum, and the fornix will be studied when it is removed.

The substance of the right hemisphere is to be removed down to the level of the upper surface of the corpus callosum. This is to be done by scraping with a blunt knife or by gently tearing away the brain matter in a lateral direction. If the dissection is being performed for the first time it is advisable to have the assistance of a demonstrator. As the white substance of the gyrus cinguli is being removed an attempt should be made to define a distinct longitudinal band which is embedded in it: this is the **cingulum.**

The **cingulum** is a band of white fibres which is embedded in the white centre of the gyrus cinguli but can be isolated from it. It begins in front in the region of the anterior perforated space and curves round the anterior end and over the upper surface and round the posterior end of the corpus callosum, and ends in the hippocampal gyrus. The cingulum is a long association bundle, the easiest of the series to dissect; it is formed by several systems of fibres which begin and end in the adjacent grey matter and run only short distances within it.

The cerebral cortex will be seen to be spread in a continuous layer over the entire surface of the hemisphere, though it is not of equal thickness in all localities: it varies from 1·25 mm. in the occipital region to 4 mm. in the pre-central convolution, and over the top of a convolution it is usually thicker than at the bottom of a fissure. The structure of the cortex cannot be studied in the dissecting-room, but it is to be stated that there are differences in structure in areas of different function: about one hundred different areas have been distinguished. One of the areas, the visual centre (p. 307), is so characteristic in its naked-eye appearance that it should be examined by making a vertical section through the occipital pole. The cortex round the post-calcarine fissure will then be seen to have in it, parallel to the surface, a white band which is named the **stria of Gennari**; and it is to be understood that this is a characteristic of the area of the cerebral cortex which is associated with the reception of sight impressions.

The dissection which has been carried out on the right hemisphere is to be repeated on the left side so that the whole upper surface of the corpus callosum is exposed. It will now be seen that the corpus callosum is formed by a mass of **commissural fibres** uniting the two hemispheres. It is to be studied at the same time on the medial face of the sectioned brain.

The **corpus callosum** is the commissural tract of the cerebral hemispheres, being formed of transverse fibres which connect all the areas of the cortices of the two sides except the hippocampal (rhinencephalon) formations. As seen on medial section (Fig. 107), it is arched from before backwards, and is placed a little nearer the anterior than the posterior end of the brain. It unites the hemispheres for about half their length. The posterior end, full and rounded, is named the **splenium**; it is the thickest part of the corpus callosum. The intermediate part, named the **body**, is much thinner. The anterior end which is bent downwards and backwards on itself is called the **genu**. The part which extends downwards and backwards from the genu is

The walls of the lateral ventricle, which are now exposed are smooth and shining for they are lined by a thin epithelial layer named the ependyma. On the medial side of each ventricle and near its anterior end, a rounded opening is to be sought it is the opening through which the lateral ventricle communicates with the third ventricle and is named the **interventricular foramen** (foramen of Monro) The shape of the ventricle is very irregular and for descriptive purposes it is divided into four parts namely a central part or body and three horn like processes which lead from it, an anterior a posterior and an inferior horn (Fig 115) The **anterior horn** is that part which lies in front of the interventricular foramen. The **body** of the ventricle extends from the interventricular foramen to the splenium of the corpus callosum, at which point the posterior and inferior horns diverge from it The **posterior horn**, very variable in its length curves backwards and medially into the occipital region, while the **inferior horn** passes downwards and forwards in the temporal region. The different parts are to be examined in detail, and at the same time vertical sections are to be made at appropriate places through one of the separated hemispheres.

The **ependyma** is the layer which lines the ventricles of the brain and the central canal of the spinal cord. Its internal surface is covered with columnar ciliated epithelium. It forms the whole thickness of some parts of the ventricular walls, for example, at the choroidal fissure on the medial side of the lateral ventricle, which will be described later and on the roof of the third ventricle and at these parts it is invaginated int the cavities of the ventricles by the pia mater which is in contact with its outer surface at them The invaginations are the **choroid plexuses** of the ventricles they secrete the cerebro-spinal fluid.

The **anterior horn** of the lateral ventricle extends forwards and laterally into the frontal region as far as the genu of the corpus callosum which forms its anterior wall When examined on a vertical section made half an inch behind the genu (Fig 116) it is seen to be triangular in outline the floor sloping upwards and laterally to meet the roof The roof is formed by the anterior part of the corpus callosum, the medial wall is vertical and consists of the septum lucidum, while in the floor there is a smooth rounded elevation which is the anterior end or head of the caudate nucleus, a part of the corpus striatum.

The **body** of the ventricle extends from the interventricular foramen to the splenium of the corpus callosum. It also is triangular in cross section. It is roofed by the corpus callosum and can be entered through it Its medial wall is formed by the posterior part of the septum lucidum. On its floor there are to be recognised the following structures (1) On the lateral side and in front is the caudate nucleus, which narrows rapidly as it passes backwards from the floor of the anterior horn and (2) on the medial side and to some extent behind the caudate nucleus is the upper surface of the thalamus These two bodies are separated by a groove which is directed backwards and laterally and

The lateral ventricle, the cavity of the cerebral hemisphere, is to be opened on each side by cutting away the corpus callosum which forms the roof of its upper part. A longitudinal incision is to be made through the corpus callosum on each side of the middle line, the two incisions to be about a quarter of an inch apart. The central part of the corpus callosum which lies between the incisions, is to be left in position but the lateral parts are to be gradually cut away until the ventricles are opened the fibres which form the forceps major do not require to be removed. It is the anterior and central parts of each ventricle that have been opened, and they should be exposed as fully as possible and a good view obtained of their interior by cutting away

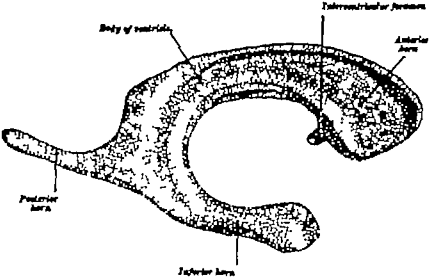


FIG. 115.
The lateral ventricle viewed from the lateral side

as much of the roof as is necessary The lateral ventricle however also extends backwards into the occipital region and downwards into the temporal region, and these parts are to be exposed on one side of the brain. The posterior or occipital part can be opened by gradually removing the substance of the tapetum which forms its roof but it is more difficult to make the dissection of the inferior or temporal part. It is best done by first cutting away the temporal operculum of the insula and then gradually removing the lateral wall of this part of the ventricle commencing behind where it can be seen to join the central part and working forwards into the temporal region. A sufficient amount of the lateral wall must be removed to give a good view of the cavity the direction of the dissection corresponds very closely with the course of the superior temporal fissure.

but distinct layer of white matter immediately outside the ependymal lining (Fig 118) On the medial wall there are two elongated elevations. The upper of them is the bulb of the cornu and is produced by the fibres of the forceps major of the splenium of the corpus callosum which curve into the occipital region on the medial side of the ventricle The lower swelling is the calcar avis it corresponds with the calcarine fissure but is very variable in size.

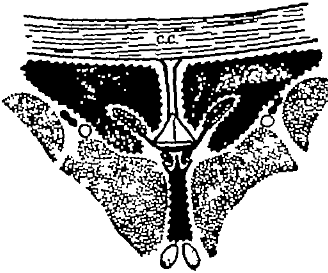


FIG. 117

A vertical section through the cerebral hemispheres dividing the bodies of the lateral ventricles. The lateral ventricles (the two triangular areas in solid black) are roofed by C.C. the corpus callosum. They are separated from one another by the septum lucidum (two heavy lines) which descends from the corpus callosum to the fornix (triangular area which is to be coloured). Below the fornix is the velum interpositum (solid black line), the edges of which project into the ventricles as the choroid plexuses. It is to be noted that the plexuses are covered by the ependyma lining the ventricles (waved white margin) which excludes them from the ventricles. In the floor of each ventricle is the caudate nucleus (C) and the thalamus (T), and in the groove between them the stria and vena terminalis. Between the thalami is the third ventricle (in solid black). Its roof is formed by the velum interpositum the under surface of which is covered with ependyma, and from it two choroid plexuses project into the ventricle.

The inferior horn of the ventricle passes downwards behind the thalamus into the temporal region and in it extends forwards and medially to within an inch of the temporal pole. The lateral wall is formed by the tapetum of the corpus callosum. In the roof at the anterior extremity of the horn, there is a small mass of grey matter named the amygdaloid nucleus, a part of the corpus striatum, and there will afterward be followed forwards to it in the roof the stria terminalis and the tail of the caudate nucleus. On the floor of the horn (Fig. 119) the dissector will first see the choroid plexus it is

in it there are to be identified a white band the stria terminalis, and the vein of the corpus striatum and the thalamus, the vena terminalis. The vein runs forwards to the interventricular foramen and there joins the vein of the choroid plexus to form the internal cerebral vein. Lying on the upper surface of the thalamus there is readily recognised the choroid plexus of the lateral ventricle. It is a highly vascular fold of pia mater which appears to lie free within the ventricle, but it is to be borne in mind that it is covered by the ependyma which excludes it from the cavity (Fig 117) Posteriorly the choroid plexus is carried into the inferior horn of the ventricle while anteriorly it

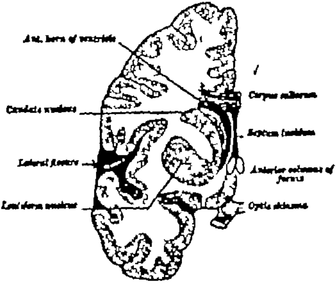


Fig. 116.

A vertical section through the cerebral hemisphere half an inch behind the genu of the corpus callosum. The form and position of the anterior horn of the lateral ventricle are shown. The insula, covered by the upper and lower opercula, is at the bottom of the lateral fissure.

reaches as far as the interventricular foramen. Above the choroid plexus there is the thin sharp lateral edge of the fornix, from under which the plexus projects that is, the choroidal fissure through which the choroid plexus is invaginated into the ventricle is the slit-like interval between the fornix above and the thalamus below A vertical section made through the centre of the thalamus will show the structures forming the walls of the body of the ventricle as is diagrammatically represented in Fig. 117

The posterior horn of the ventricle describes a gentle curve, convex laterally backwards into the occipital region. The roof and lateral wall of the horn are formed by the tapetum of the corpus callosum, which is well seen in vertical sections through the splenium as a thin

but distinct layer of white matter immediately outside the ependymal lining (Fig 118) On the medial wall there are two elongated elevations. The upper of them is the bulb of the cornu and is produced by the fibres of the forceps major of the splenium of the corpus callosum which curve into the occipital region on the medial side of the ventricle The lower swelling is the calcar avis it corresponds with the calcarine fissure but is very variable in size.

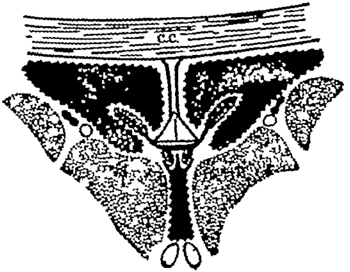


Fig. 117

A vertical section through the cerebral hemispheres dividing the bodies of the lateral ventricles. The lateral ventricles (the two triangular areas in solid black) are roofed by C.C. the corpus callosum. They are separated from one another by the septum lucidum (two heavy lines) which descends from the corpus callosum to the fornix (a triangular area which is to be coloured). Below the fornix is the velum interpositum (solid black line), the edges of which project into the ventricles as the choroid plexuses. It is to be noted that the plexuses are covered by the ependyma lining the entricles (waved white margin) which excludes them from the ventricles. In the floor of each ventricle is the caudate nucleus (C) and the thalamus (T), and in the groove between them the stria and vena terminalis. Between the thalami is the third ventricle (in solid black). Its roof is formed by the velum interpositum the under surface of which is covered with ependyma, and from it two choroid plexuses project into the ventricle.

The inferior horn of the ventricle passes downwards behind the thalamus into the temporal region and in it extends forwards and medially to within an inch of the temporal pole The lateral wall is formed by the tapetum of the corpus callosum. In the roof at the anterior extremity of the horn, there is a small mass of grey matter named the amygdaloid nucleus a part of the corpus striatum, and there will afterwards be followed forwards to it in the roof the stria terminalis and the tail of the caudate nucleus On the floor of the horn (Fig. 119) the dissector will first see the choroid plexus it is

continuous behind the thalamus with the choroid plexus of the body of the ventricle. If it is turned aside the hippocampus which it covers will be seen. This is an elevation of grey matter which extends the entire length of the floor and is curved like the ventricle itself so that its medial margin is concave and its lateral margin convex. It is narrow behind but expands as it passes forwards, and it ends in front in a thickened extremity The surface of the anterior end is marked by two or three faint grooves, and it is named the pes hippocampi (Fig. 120). Attached to the medial concave border of the hippocampus there is a distinct though narrow band of white matter It is named the fimbria, and the white fibres which form it are continuous with the white layer the alveus, which is spread over the surface of the hippocampus though it is not easily distinguished. The fimbria will afterwards be seen to be continued into the fornix On the lateral side of the hippocampus there may be a smooth swelling, the eminentia collateralis, which may be continued backwards into the interval between the hippocampus and the calcar avis It corresponds to the collateral fissure, but there are great differences in its development. In a vertical section through the inferior horn the arrangement of the structures described above will be seen as diagrammatically represented in Fig. 119

The remains of the temporal region are now to be detached from the hemisphere so that the floor of the inferior horn can be more closely studied. This is easily done by cutting through the forceps major and the fimbria behind and the temporal pole in front. The hippocampus and the fimbria are now seen to lie above and a little on the lateral side of the hippocampal gyrus of the temporal region (Fig. 119). The medial edge of the fimbria is to be raised from the hippocampal gyrus, and there will be seen in the interval between them a free notched edge of grey matter (Fig. 119) *This is the gyrus dentatus. It is separated* from the fimbria by the fimbrio-dentate sulcus and from the hippocampal gyrus by the hippocampal sulcus which, however except at its anterior end, is not constantly present in the adult brain. The gyrus dentatus passes as far forwards as the uncus of the hippocampal convolution, into the cleft of which it appears to run, while posteriorly round the splenium of the corpus callosum, it is continued into the indusium griseum (gyrus supracallosus) (p. 311) The gyrus dentatus, the hippocampus, the indusium griseum, and the gyrus paraterminalis (gyrus subcallosus) are the parts of the hippocampal formation they receive the olfact ry neurones from the lower olfactory centres and constitute the olfactory cortex.

The central part of th corpus callosum which is still in position is to be pared away t its edges until the septum lucidum and the fornix are seen as well as is possible The septum lucidum should also be examined on the medial face of the divided brain. It is triangular in shape and fills the nterval between the corpus callosum above and the fornix below to b th of which it is ttached (Fig 107). The narrow middle strip of the c rpus call sum is now to be removed. It should be cut across behind the genu and raised backwards, the upper edge

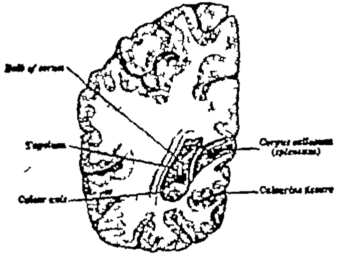


FIG. 118.
A vertical section through the cerebral hemisphere dividing the posterior horn of the lateral ventricle.

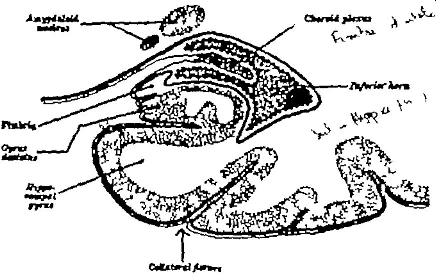


FIG. 119.
A vertical section through the inferior horn of the lateral ventricle. The hippocampus is the area of gray matter on the floor of the ventricle below the choroid plexus and along the medial edge of which are the fimbria and the gyrus dentatus; below and medial to the hippocampus is the hippocampal gyrus.

of the septum lucidum being separated from its lower surface. Behind the septum lucidum the corpus callosum covers and is connected to the fornix, but it should be removed from it as far back as the splenium. The upper edge of the septum lucidum is then to be clipped with scissors in this way the two laminæ of which it is formed and the cleft between them will be shown (Fig. 120).

The septum lucidum can now be seen to be a thin vertical partition which intervenes between, and forms the medial walls of the anterior horns and the

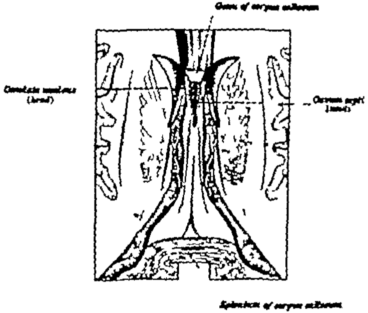


FIG. 120.

Dissection of the fornix from above. The corpus callosum has been cut across at the genu and at the splenium and the intervening part has been removed. The septum lucidum is seen in front and behind it the upper surface of the fornix. The choroid plexuses project into the lateral ventricles below the edges of the fornix; they are to be coloured.

front parts of the bodies of the lateral ventricles (Fig 120). It consists of two thin laminæ separated by a narrow cleft named the cavum septi lucidi, which varies very much in size in different brains. It is a completely closed space, communicating neither with the ventricles nor with the exterior The laminæ of the septum contain both grey and white matter

A considerable part of the fornix can now be seen from above (Fig 120) and if at the same time it is examined on the medial surface of the sectioned hemisphere (Fig 107) its *form* and relations will be understood. On the medial view it is seen to be a highly arched *structure*. It is the efferent pathway from the hippocampal formation

and commences posteriorly as a continuation of the fimbria of the hippocampus and it arches forwards below the corpus callosum to which it is adherent behind but from which it is separated in front by the septum lucidum. In this part of its course as seen from above it comes into close contact with the fornix of the opposite side and some decussation of fibres takes place the decussating fibres connect the hippocampal formations of the two sides and constitute the hippocampal commissure Anteriorly the parts of the two fornices again separate and pass downwards to the base of the brain to end in the corpora mammillaria.

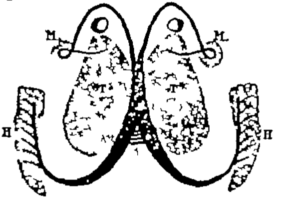


FIG. 121.

Diagram of the form and connexions of the fornix. The fornix (in solid black) commences behind on the hippocampus (H) as the fimbria which lies on its medial edge and derives its fibres from the alveus which is spread over the surface of the hippocampus. As the posterior column of the fornix it curves round the back of the thalamus (T) and comes into close contact with the posterior column of the opposite side, some decussation of fibres taking place (horizontal lines). The body of the fornix, formed by the apposed parts of the two sides, separates in front into the two anterior columns, each of which passes in front of the interventricular foramen (black circle between it and the anterior end of the thalamus) and ends in the corpus mamillare (M). The corpus mamillare is connected to the anterior end of the thalamus by the mamillo-thalamic tract.

The fornix may be described for purposes of topography to consist of a central part or body and two anterior and two posterior columns into which the body divides; but strictly speaking the body is formed by the apposition of the fornix systems of the two hemispheres (Fig 121). The body is triangular in shape, being narrow and rounded in front and broad and flattened behind. Its upper surface is adherent to the under surface of the back part of the corpus callosum but in front of this it is attached to the lower edge of the septum lucidum. On each side the edge of this part of the fornix *projects* into the body of the lateral ventricle in the form of a sharp margin from under which the choroid plexus emerges. The lower surface rests on the velum interpositum, as will be seen when it is reflected. The anterior columns are two rounded strands which *diverge only slightly from* one another and pass downwards to the base of the brain. In its course each anterior column lies in front of the interventricular foramen of which it forms the anterior boundary

and then on the lateral wall of the front part of the third ventricle. Its ending in the corpus mamillare and the connexion of this body with the anterior end of the thalamus will be dissected later. The posterior columns are flattened bands and diverge widely from each other as they sweep backwards and downwards. Each column passes round the posterior end of the thalamus and then enters the inferior horn of the lateral ventricle where, as the fimbria, it lies on the hippocampus and spreads as the alveus over its surface.

The fornix so described is constituted by the apposed fornices of the two sides, each of which commences behind as the alveus and terminates in front in the corpus mammillare.

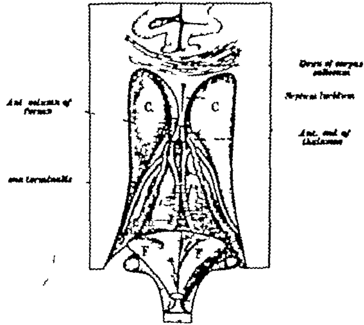


FIG. 122.

Dissection of the velum interpositum from above. The fornix has been cut across and its back part (F F) thrown backwards from the upper surface of the velum interpositum. In the velum are seen the internal cerebral veins (of Galen). The interventricular foramen of each side lies between the anterior column of the fornix and the anterior end of the thalamus. C C, Caudate nuclei.

The body of the fornix is to be cut across at the level of the interventricular foramen and the posterior part raised and turned backwards. This dissection will expose the upper surface of the velum interpositum (tela chorioidea anterior) (Fig 122). This is a two layered fold of pia mater which lies between the body of the fornix above and the upper surface of the thalami and the roof of the third ventricle below (Fig 117). It is triangular in shape, the anterior pointed end being placed at the interventricular foramina and the base below the

splenium of the corpus callosum. The edges of the fold contain the choroid plexuses of the bodies of the lateral ventricles, while between the two layers of which it is formed there are the internal cerebral veins (of Galen) and some sub-arachnoid trabecular tissue.

The velum interpositum consists of two layers of pia mater which intervene between the cerebral hemisphere above and the thalamencephalon below (Fig 105) The two layers separate from one another at the base of the velum, the upper layer passing onto the splenium of the corpus callosum and the lower layer over the corpora quadrigemina on the dorsal surface of the mid brain. The choroid plexus of each lateral ventricle consists of convoluted blood vessels arranged in tufts and enclosed within the folds of the pia mater It projects into the body of the ventricle from the edge of the velum interpositum, but is covered by the ependymal lining which excludes it from the cavity (Fig 117). Anteriorly at the interventricular foramen, the choroid plexus becomes smaller and is continuous with the plexus of the opposite side across the middle line posteriorly it is continuous with the choroid plexus of the inferior horn of the ventricle.

The fissure on the medial wall of the hemisphere through which the choroid plexus is invaginated into the lateral ventricle is named the choroidal fissure. It is a narrow ⊃ -shaped slit, the upper part leading to the body of the ventricle and the lower part into the inferior horn. As may be seen on the medial surface of the brain it is bounded on its convex side by the fornix and its continuation the fimbria, while in the concavity between its two limbs lies the thalamus. As the choroid plexus enters the fissure it pushes the ependymal lining of the ventricle before it.

The most conspicuous blood vessels in the velum interpositum are the internal cerebral veins of Galen (Fig 122). They are two in number and run backwards, one on each side of the middle line. In front each is formed at the interventricular foramen by the union of the vena terminalis (p. 314) and a large vein which issues from the choroid plexus; posteriorly the two internal cerebral veins unite to form the great cerebral vein of Galen which opens into the straight sinus (p. 188).

The Thalamencephalon

The further dissection of the cerebral hemispheres must be postponed until the thalamencephalon (diencephalon) and the mid brain have been examined. The thalamencephalon is that part of the fore-brain which lies behind the interventricular foramina which represent the stalks of the cerebral hemispheres and its cavity is the major part of the third ventricle (Fig 105) The lateral walls of this part of the embryonic neural tube undergo great thickening and form two large nuclear masses named the thalami. The lateral surfaces of the thalami are at first free but later in development they are applied to and fuse with the medial surfaces of the cerebral hemispheres and in the adult brain, are embedded in them close to the corpora striata. They and the other structures of this part of the brain will be exposed as the third ventricle is opened.

The vena terminalis is to be cut as it enters the apical part of the velum interpositum and this membrane is to be turned backwards

the substance of the hemisphere its lateral surface being applied to a mass of white matter the internal capsule which belongs to the hemisphere and its under surface to the upward continuation of the tegmentum of the mid brain but it is free above where it appears on the floor of the lateral ventricle and on the medial side where it forms the wall of the third ventricle. It is convenient, therefore, to describe these four surfaces separately

The anterior end of the thalamus, often called the anterior tubercle, is narrow and pointed. It lies close to the middle line and forms the posterior boundary of the interventricular foramen (Fig 122) The posterior end is enlarged and prominent and overlaps the lateral parts of the corpora quadrigemina. On its medial side there is a rounded prominence named the pulvinar and below and to the lateral side of it there is a smaller oval swelling, the **lateral geniculate body** (Fig 123) The lateral surface of the thalamus, as seen in section, is applied to a thick mass of white matter called the **internal capsule**, while the inferior surface rests on parts which form the sub-thalamic tegmental region this and the internal capsule will be studied later The superior surface is slightly convex; it is covered with a thin layer of white matter the stratum zonale. It is separated laterally from the caudate nucleus by the groove which contains the stria and vena terminalis, while on the medial side it is separated from the medial surface by a prominent ridge named the tænia thalami. *It is along this ridge that the epithelial roof of the third ventricle is attached to the thalamus.* Deep to the tænia and accentuating it there is a longitudinal strand of white fibres named the **stria habenularis** which turns medially at its posterior end and forms the anterior boundary of the **trigonum habenulæ** (Fig 123). The upper surface of the thalamus thus defined is divided into two parts by a shallow oblique groov which runs from behind forwards and medially; it corresponds to the lateral free edge of the body of the fornix. The lateral area forms the medial part of the floor of th lateral ventricle with the ependyma of which it is covered, while the medial area is covered by the velum interpositum and takes no part in the formation of the wall of either the lateral or the third ventricle (Fig 117) The medial surface forms the upper part of the lateral wall of the third ventricle as far forwards as the interventricula foramen; it is usually connected t the opposite thalamus by a flattened grey band named the **connexus inter thalamicus**.

The structure of the thalamus will be studied when it is sectioned horizontally for then its connexions can be more easily described. The medial and lateral **geniculate bodies** which lie behind the posterior end of the thalamus and constitute the metathalamus will be described with the mid brain though they develop from and belong to the thalamencephalon.

The **pineal body** the **trigonum habenulæ**, and the **posterior commissure** constitute the epithalamus they are to be studied now

The pineal body a gland of internal secretion whose function is not yet fully underst od, is a small conical *dark-coloured body about the size of a* cherry-stone which projects behind the third ventricle and lies in the interval between the superior corpora quadrigemina (Fig 123). It is enveloped by the

lower layer of the velum interpositum. The apical part of the body directed backwards, is free, while the broad basal part which is directed forwards is attached by a hollow stalk of whit matter into which the third ventricle is continued in the form of a pointed recess. The stalk is thus divided into dorsal and ventral layers, the former of which is continuous with the habenular commissure while the latter is folded round the posterior commissure. The structure of the pineal body cannot be examined in the dissecting-room, but the student should make sections of it to find the particles of calcareous matter (brain sand) which are present in it in the adult; in the young it is an active cellular organ but it soon undergoes fibrosis.

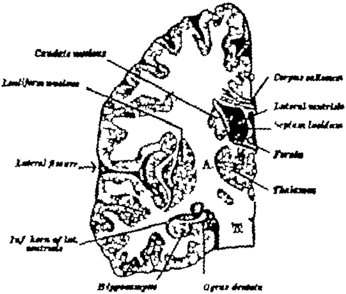


FIG. 124.

A vertical section of the cerebral hemisphere through the thalamus. The tail of the caudate nucleus is seen in the roof of the inferior horn of the lateral ventricle and is to be named.

A. The internal capsule; B. the sub-thalamic tegmental region.

The trigonum habenulae is a small depressed triangular area situated medial to the posterior part of the thalamus from which it is separated by a shallow sulcus. It contains a group of nerve cells, the habenular nucleus, into which the fibres of the stria habenularis pass. The stria is formed at the anterior end of the thalamus by fibres which ascend from the anterior perforated space and others from the anterior column of the fornix they terminate partly in the nucleus of the same side and partly in the nucleus of the opposit side, the crossing fibres forming the habenular commissure in the dorsal part of the stalk of the pineal body The efferent fibres from the habenular nucleus form the fasciculus retroflexus which passes ventrally into the mid-brain and ends there in the interpeduncular nucleus and the substantia nigra. The habenular nucleus and its afferent and efferent paths are part of the efferent mechanism of the rhinencephalon.

The posterior commissure is a narrow cord-like band of white fibres which crosses the middle line below the ventral layer of the stalk of the pineal body; it lies dorsal to the upper end of the aqueduct of the mid-brain. The connexions of its fibres are not yet fully known, but some of them have their origin in a nucleus of the mid-brain (nucleus of Darkschewitsch) which lies dorso-lateral to the nucleus of the oculo-motor nerve.

The third ventricle is now to be examined. It is a narrow deep cleft which lies in the middle line between the thalami, and as seen from above and on the medial face of the sectioned brain extends from the pineal body behind to the lamina terminalis and the anterior commissure in front. It communicates anteriorly with the lateral ventricles through the interventricular foramina which, as seen from above, pass laterally between the anterior columns of the fornix and the anterior tubercles of the thalami. It communicates posteriorly with the fourth ventricle through a narrow channel, the cerebral aqueduct of Sylvius, which tunnels through the mid-brain (Fig. 107). The opening of the aqueduct is to be seen on the medial section immediately below the posterior commissure. The general shape of the third ventricle is triangular, the apex being directed backwards, and its walls are the roof, the floor, the lateral wall, and the anterior and posterior walls.

The roof consists of a thin epithelial layer of ependyma which stretches from the tænia thalami of one side to that of the other. It is covered by and adherent to the under surface of the velum interpositum with which it is torn away when the velum is removed. From the under surface of the velum two choroid plexuses, one on each side of the middle line, project downwards and invaginate the roof into the cavity (Fig. 117). The floor slopes downwards and forwards and is formed mainly by the structures which constitute the hypothalamus. These structures, from before backwards, are the optic chiasma, the tuber cinereum and the infundibulum, the corpora mammillaria, and the region of the posterior perforated space, all of which were previously described to lie in the interpeduncular fossa (p. 285). The pituitary gland is attached to the lower end of the infundibulum. The lateral walls are chiefly formed by the medial surfaces of the thalami, and in front of the interventricular foramina by the anterior columns of the fornix which are to be seen embedded in the grey matter on the sides of the ventricle. Below the thalami the lateral walls are formed by upward continuations of the grey matter of the floor of the ventricle, and there is reason to suppose that in these parts there are nuclei which are higher centres for the sympathetic and parasympathetic systems; the nuclei are grouped together as the hypothalamic nuclei. The anterior boundary is formed by the lamina terminalis which runs downwards to the upper edge of the optic chiasma from the anterior commissure (Fig. 107). The posterior boundary is formed by the pineal body and the posterior commissure and below them has in it the opening of the cerebral aqueduct.

The outline of the third ventricle thus bounded is very irregular (Fig. 107). It should be examined on the medial face of the sectioned brain where the recesses which lead from it can be seen. From the anterior part of the floor there is a deep funnel-shaped recess leading down into the infundibulum of the pituitary gland, and above this another recess passes in front of the optic

them round the lateral sides of the mid brain and onto its ventral surface where they were previously found (p 286)

From the lateral side of each corpus quadrigeminum a band of white matter named the brachium, is prolonged upwards and forwards under the pulvinar of the thalamus The brachia of each side are separated from one another by a continuation of the transverse limb of the cruciate sulcus. When followed laterally the inferior brachium will be seen to pass under a small but sharply defined oval eminence which lies under cover of the pulvinar of the thalamus it is the medial geniculate body The superior brachium runs between the medial

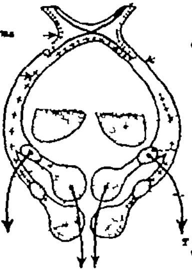


FIG 125

Diagram of the central connections of the optic nerves.

geniculate body and the pulvinar and appears in part to enter the lateral geniculate body and in part to be directly continued into the optic tract (Fig 125)

The central connexions of the optic nerves may well be considered now The optic nerve arises in the retina and passes backwards to the optic chiasma. At the chiasma the fibres which arise in the medial (nasal) half of the retina, including the nasal half of the macula lutea, decussate with the corresponding fibres of the opposite side the lateral (temporal) fibres take no part in the decussation. The optic tract, therefore, which commences at the chiasma contains fibres which arise in the lateral half of the retina of the same side and fibres which

chiasma. From the posterior wall two recesses pass backwards; one, the pineal recess, passes into the stalk of the pineal body above the posterior commissure, the other is placed above this and is named the supra-pineal recess; its walls are epithelial and it is destroyed in an ordinary dissection.

At this stage of the dissection the anterior column of the fornix should be traced downwards along the front part of the side wall of the third ventricle to the corpus mamillare on the sectioned brain. The dissection is not difficult for the column is a distinct rounded bundle and is easily isolated. The fibres of the fornix end in the corpus mammillare, though if this body is dissected the appearance is that the column loops on itself and passes upwards to the anterior end of the thalamus (Fig 121) The ascending tract, the **mammillo-thalamic tract**, is, however a new bundle, its fibres arising from the mass of grey matter which constitutes the mammillary body Through the mammillo-thalamic tract the olfactory impressions from the hippocampus, from which the fornix comes (p. 319) are brought to the thalamus and there correlated with the other sense impressions which are conveyed to it by the sensory paths entering it from below

The Mid-brain

The **mid-brain** is a short thick part of the brain, about three-quarters of an inch long and connects the cerebral hemispheres and sub-thalamic regions in front with the pons, medulla, and cerebellum behind. It lies in the gap of the tentorium cerebelli. Its superficial characters are to be examined first. It consists of two parts a dorsal part and a ventral part, separated from one another by the cerebral aqueduct which traverses it from end to end nearer the dorsal than the ventral side (Fig 107) (1) The dorsal part, the **tectum** or **lamina quadrigemina**, is completely covered in the undissected brain and, as may be seen on the sectioned specimen, is overlaid by the splenium of the corpus callosum (Fig 107) (2) The ventral part is formed by the two **cerebral peduncles** or **crura cerebri** which are to be seen on the base of the brain.

The **tectum** (**lamina quadrigemina**) is to be brought into view by pulling the cerebellum as far back as possible The four rounded eminences into which it is divided, the **corpora quadrigemina**, two **superior** and two **inferior** are readily recognised the superior pair are larger and broader but not so well defined as the inferior pair. The corpora quadrigemina are separated from one another by a cruciate sulcus. The longitudinal limb of the sulcus lies in the middle line. At its anterior end it broadens considerably and has resting in it the pineal body while from its lower end a narrow band of white fibres the **frenulum veli**, passes onto the **superior medullary velum**, that is the roof of the anterior part of the fourth ventricle (Fig 107) The **trochlear** (fourth cranial) **nerves** are attached at the sides of the frenulum and care is to be taken to secure them at once and follow

superficial substance On the medial side of each peduncle which looks into the interpeduncular fossa there is a longitudinal sulcus from which the roots of the oculo-motor (third cranial) nerve emerge the sulcus is named the oculo-motor sulcus.

The mid brain is now to be cut through transversely at the level of the inferior corpora quadrigemina so that the structure of its interior may be examined. There can be distinguished at once on such a section (Fig 196) (1) The **cerebral aqueduct** of Sylvius which tunnels through the mid brain and connects the third ventricle in front with the fourth ventricle behind It is about 15 mm. long It lies nearer the dorsal surface and on transverse section it appears as a small triangular or

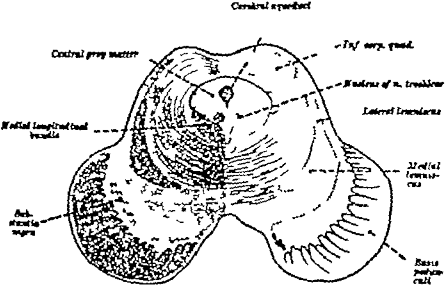


Fig 196.

Diagram of transverse section of the mid brain through the inferior corpora quadrigemina.

T-shaped opening The aqueduct is lined with ciliated columnar epithelium and is surrounded by a layer of grey matter the **central grey matter** which can usually be distinguished with the naked eye it is continuous above and below with the grey matter of the third and fourth ventricles. The area of the mid brain which lies above the level of the aqueduct is the lamina quadrigemina and that below belongs to the cerebral peduncles. (2) The **substantia nigra** is a conspicuous darkly pigmented layer of grey matter on each side, crescentic in outline on transverse section, and divides the peduncle into a dorsal part the **tegmentum**, and a basal part, the **base** (basis pedunculi) The surface of the substantia nigra towards the tegmentum is concave and smooth but the opposite surface is convex and highly irregular for numerous small pointed processes pass from it into the

arise in the medial half of the retina of the opposite side. From the optic chiasma the optic tract passes backwards and laterally between the tuber cinereum and the anterior perforated space, forming the antero-lateral boundary of the interpeduncular fossa it then becomes flattened and winds dorsally round the cerebral peduncle, to which it closely adheres towards the corpora quadrigemina. At its dorsal end it divides into two ill-defined roots. The medial root enters the medial geniculate body The fibres which compose it do not arise in the retina, that is, they are not visual fibres. They arise in the medial geniculate body of one side, pass forwards in the optic tract to the optic chiasma and cross to the opposite side in its posterior part they then pass backwards in the opposite optic tract to the inferior corpus quadrigeminum and medial geniculate body They thus form a commissure in the visual pathway which links the medial geniculate body of one side to the inferior corpus quadrigeminum and medial geniculate body of the opposite side these parts are the lower auditory centres and the commissure between them is known as the commissure of Gudden. The lateral root, which contains mainly fibres arising in the retina but also some fibres passing forwards to the retinae from the cerebral centres, is continued partly into the superior brachium and through it to the superior corpus quadrigeminum but mostly it passes into the lateral geniculate body (Fig. 125) These parts, the superior corpus and the lateral geniculate body in which the visual fibres of the optic tract end constitute the lower visual centres. New fibres arise from the nerve cells of the lateral geniculate body and, as the optic radiation, pass through the posterior limb of the internal capsule and backwards and medially into the occipital region on the lateral side of the posterior horn of the lateral ventricle. They end in the visuo-sensory area of the cerebral cortex round the post-calcarine fissure and below the calcarine fissure. The superior corpus quadrigeminum gives rise to fibres which, as the tecto-bulbar and tecto-spinal tracts, descend to the motor nuclei of the third, fourth, sixth, and eleventh cranial nerves and the motor nuclei of the upper spinal nerves and through them the corpus is concerned in the visual reflexes and the co-ordinated movements of the eyes and the eyes and the head (p. 202)

The medial geniculate body and the inferior corpus quadrigeminum are the lower auditory centres the auditory pathway the lateral lemniscus, which will be described later terminates in them. The geniculate body relays the auditory fibres to the audito-sensory area in the temporal region while the inferior corpus is a centre for auditory reflexes.

The cerebral peduncles, or crura cerebri, form the chief bulk of the mid-brain. When viewed from below (Fig 106) they appear as two large strands which emerge close together from the upper margin of the pons and diverge as they pass upwards t the cerebral hemispheres winding round each peduncle as it enters the hemisphere is th optic tract. The surface of the peduncles is spirally streaked in a longitudinal direction, indicative of the direction of the fibres which form their

The study of the mid-brain is to be completed by examining Figs. 126 and 127 which are diagrams of transverse sections at the levels of the inferior and superior corpora quadrigemina and show the main features of their structure as seen on prepared specimens. It is not possible to see all of these details in a dissecting room section but the student should at least make similar sections and study them with a hand-lens.

The tegmentum is composed of a mixture of grey matter and white fibres, forming what is called a formatio reticularis. The principal mass of grey matter is the red nucleus, a large ovoid mass which lies in the medial part of the tegmentum of the anterior part of the mid brain, and extends upwards into the sub-thalamic region; in sections at the level of the superior corpus it appears as a circular mass slightly reddish in colour (Fig 127) Most of the fibres of the brachium conjunctivum and some of the efferent fibres of the corpus striatum end in it, while the axons of the majority of its cells cross the middle line and are continued downwards as the rubro-spinal tract; this tract ends round the motor nuclei of the brain stem and spinal cord. The red nucleus is thus a cell station in the efferent paths of the cerebellum and corpus striatum and must play an important part in the nervous mechanism of movements. The tegmentum is continued upwards under the thalamus as the sub-thalamic tegmentum and there is in it there a small sub-thalamic nucleus (Fig 134); this nucleus also receives fibres from the corpus striatum, and though still uncertain its functions are also concerned in the control of movements. The white fibres of the tegmentum are both longitudinal and transverse in direction and are for the most part gathered together to form bundles (or paths or tracts). The medial longitudinal bundle is one of them (Fig 127). It *forms a compact mass almost vertical* in direction at the side of the median raphe below the central grey matter round the cerebral aqueduct. Its fibres are chiefly derived from the nuclei of the vestibular nerve and they end round the motor nuclei of the mid brain and hind brain The brachia conjunctiva (superior cerebellar peduncles) are derived from the cerebellum and converge as they pass up towards the mid brain; stretching between them there is a thin lamina of whit matter the superior medullary velum They sink below the inferior corpora quadrigemina and in a section through these bodies appear as two white semilunar tracts below the median longitudinal bundles. They decussate with one another across the middle line and end mainly in the red nuclei. A third bundle which should be sought is the ascending path of the general body sensations; it is named the medial lemniscus (Fig 126). It forms a flattened tract dorsal to the substantia nigra, but as it ascends it inclines laterally and lies on the lateral side of the red nucleus. It passes into the sub-thalamic region and there its fibres enter the *ventro-lateral surface of the thalamus and end in* t. *There is* another ascending path consisting of fibres derived from the nuclei of the cochlear division of the auditory nerve and conducting therefore, impulses of hearing; it is named the lateral lemniscus (Fig 126). It lies lose t the surface of the tegmentum opposit the lateral sulcus, from which ts fibres finally emerge and pass into the medial geniculate body and the inferior corpus quadrigeminum. The lateral lemniscus may conveniently be named the auditory tract. The nuclei of the third and fourth cranial nerves lie in the central grey matter on the floor of the cerebral aqueduct, the one t the level of the superior corpus and the other at the level of the inferior corpus quadrigeminum. They cannot be more than recognised

base. Its margins come to the surface at the oculo-motor groove on the medial side and at a shallow depression, the lateral sulcus, on the lateral side. The substantia nigra extends into the sub-thalamic region above. Its fibre connexions and functions are still obscure. (3) The base of each side is crescentic in outline. It is quite separated from that of the opposite side (Fig. 126). It is composed almost entirely of longitudinal fibres which arise from the cerebral cortex and descend through the mid-brain. It is not possible in the natural state to distinguish the different tracts, but the student should remember that those which lie in the middle three-fifths are derived from the cells of the motor cortex (pre-central convolution) and constitute the motor

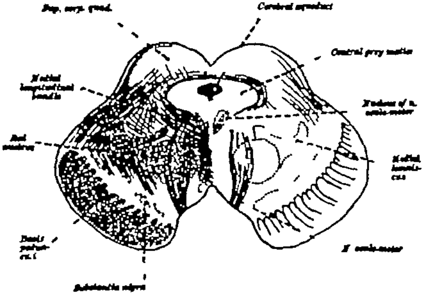


FIG. 127

Diagram of a transverse section of the mid brain through the superior corpora quadrigemina.

(cerebro-spinal, pyramidal) path. They descend through the pons and medulla where some of them end in the motor nuclei of the opposite side, but most of them are continued into the pyramids of the medulla and thence into the spinal cord. The fibres in the medial fifth are those of the fronto-pontine tract and those in the lateral fifth the temporo-pontine tract. These tracts originate in the frontal and temporal regions of the cortex and end in the nuclei of the pons. New fibres arise from the pontine nuclei and pass into the cerebellar hemisphere. (4) The tegmentum extends across the whole width of the mid brain there being only an ill-defined median raphe indicating its division into lateral halves. It is in no way separated from the lamina quadrigemina above.

substance of the hemisphere and for the most part is related to the medial side of the internal capsule (Fig 128)

The **lentiform nucleus** is almost completely embedded in the white matter of the hemisphere on the lateral side of the caudate nucleus and the thalamus it can only be seen, therefore in sections of the brain (Fig. 128) In horizontal sections it has the appearance of a biconvex lens, the lateral surface being flatter than the medial surface while in vertical sections it is more or less triangular the apex pointing

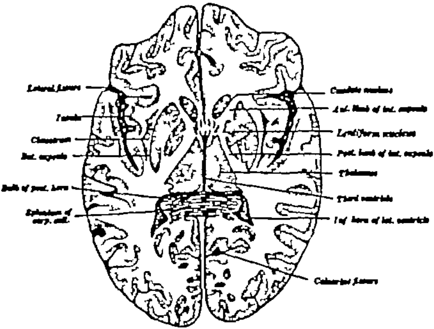


FIG. 128.

A horizontal section through the cerebral hemispheres below the upper parts of the lateral ventricles.

towards the interval between the caudate nucleus and the thalamus. It is shorter than the caudate nucleus and does not extend so far forwards, but the lower anterior parts of the two nuclei are connected together by bands of grey matter which cross the anterior part of the internal capsule (Fig 116) It is owing to the ribbed appearance presented by a section through these connexions that the two nuclei have been named the corpus striatum. The lateral surface of the lentiform nucleus is related to a thin lamina of white matter named the **external capsule**, lateral to which there is a thin layer of grey matter

on unprepared sections, but the emerging fibres of the third nerve can usually be seen to sweep ventrally many of them through the red nucleus, and to emerge at the oculo-motor sulcus on the medial side of the cerebral peduncle (Fig 127)

The Corpus Striatum and the Thalamus

The caudate and lentiform nuclei of the cerebral hemisphere the chief parts of the corpus striatum, are now to be examined, and while this is being done it is possible also to study the structure of the thalamus and a series of related parts of the hemisphere which are of clinical importance. The study is to be made by cutting a succession of thin horizontal sections through the parts of the cerebral hemisphere below the level of the floor of the body of the lateral ventricle and this can be most conveniently done on the hemisphere in which the occipital and temporal horns of the ventricle are not opened. The vertical sections which were made through the detached hemisphere of the other brain are also to be used in the study and if it has not already been made, one of these sections should be cut so as to pass through the anterior commissure. By examining both sets of sections and piecing together the information to be gained from them, the form and relations of the caudate and lentiform nuclei and the internal capsule of white matter which lies between them can be learned.

The corpus striatum is a mass of grey matter which develops in the ventro-medial part of the cerebral hemisphere in the area immediately behind the interventricular foramen (Fig 105) It is therefore immediately lateral to the thalamus and at first is separate from it but as the two bodies enlarge they come into contact and the interval between them disappears. When the projection (itinerant) fibres (p. 300) of the cerebral hemisphere develop they pass through the corpus striatum and divide it into medial and lateral parts, the caudate and lentiform nuclei other subsidiary parts of the corpus are the amygdaloid nucleus (p. 315) and the claustrum.

The caudate nucleus, a mass of grey matter has already been examined in connexion with the lateral ventricle. It is a highly arched ⊃ or horseshoe-shaped structure, the upper and anterior part of which is expanded as the head of the nucleus and the remainder narrowing rapidly forms the long attenuated tail. The head of the nucleus projects into the anterior horn of the lateral ventricle of which it forms the floor (Fig 116) and is carried backwards on the floor of the body of the ventricle on the lateral side of the thalamus, from which it is separated by the groove containing the stria terminalis (Fig 117). Both parts are crossed by veins of some size which end in the vena terminalis. The tail of the nucleus turns downwards and then passes forwards in the roof of the inferior horn of the ventricle, in which it is prolonged to the amygdaloid nucleus (Fig 121). The ventricular (convex) surface of the nucleus is thus easily examined the deep (concave) surface, as seen in the sections, is embedded in the white

level of activity in which there is a large emotional content. The impulses which reach the cortex from the thalamus are more definitely appreciated they can be localised, analysed, and related to past experience and they have their outlet through the cortical motor centres.

The **internal capsule** is the broad band of white matter which intervenes between the lentiform nucleus on the lateral side and the caudate nucleus and the thalamus on the medial side. In horizontal sections especially (Fig 123) it is seen to be bent upon itself opposite the interval between the caudate nucleus and the thalamus. The apex of the bend, which is pointed medially is named the **genu**. The part of the capsule which lies anterior to the genu and between the lentiform and caudate nuclei is called the **anterior limb** the part which lies posterior to the genu and between the lentiform nucleus and the thalamus is named the **posterior limb**. The anterior limb is broken up in front by the bands of grey matter which pass between the head of the caudate nucleus and the anterior part of the lentiform nucleus but the posterior limb is a solid mass of white nerve fibres, and as seen in vertical sections (Fig 124) is directly continuous below with the cerebral peduncle of the mid-brain. The internal capsule contains practically all the projection (itinerant) fibres of the cerebral hemisphere and lesions of it will interrupt the connexions of the cortex with the parts below The arrangement of the fibres in the capsule each group of them in its own place, is described in the text-book here the student is only reminded that among the fibres of the posterior limb are those of the **motor** (cerebro-spinal pyramidal) and **sensory tracts**. The former tra t, originating in the pre-central motor convolu tion of the cerebral hemisphere, passes through the capsule to the parts below occupying the region of the genu and the anterior two-thirds of the posterior limb the latter tracts, consisting of fibres derived from the thalamus which are concerned with the general body sensations and of fibres from the lower visual and lower auditory centres of the mid brain, radiate upwards through the medial part of the posterior third of the posterior limb to the cortical centres of the hemisphere. The internal capsule is crossed by the striate arteries (p 297).

The Hind-brain

The parts which form the hind-brain are grouped round the fourth **ventricle**, the **pons** and the **medulla oblongata** lying anterior to it and forming its floor and the **cerebellum** posteriorly and in its roof. The student has at his command two specimens of these parts, one in which the hind-brain is intact and one in which it is divided longitudinally in the middle line. On the intact specimen the external features of the three parts of the hind brain are to be studied.

The ventral surface alone of the pons can be seen its dorsal surface faces into and forms the upper part of the floor of the fourth ventricle (Fig. 130) The ventral surface forms a prominence on the base of the brain, convex from side to side and to a less extent from above

named the claustrum the claustrum intervenes between it and the subcortical white matter of the insula. The medial surface of the nucleus is applied to the internal capsule. The inferior surface of the nucleus is deeply grooved by the anterior commissure and below the groove is continuous with the grey matter of the anterior perforated space. It is here that the striate arteries which perforate the space enter the nucleus the account of the arteries given on p. 297 should be read again. In a vertical section through the middle of the nucleus it is seen to be divided into three parts by two white medullary laminæ the lateral and largest part, dark in colour is named the putamen and the two medial parts, much lighter in colour together form the **globus pallidus.**

The claustrum (Fig 128) is a thin lamina of grey matter embedded in the white matter between the lentiform nucleus and the insula, with the latter of which it corresponds in extent. Its medial surface is smooth but its lateral surface presents ridges and furrows which correspond with the convolutions and fissures of the insula.

The Connexions of the Corpus Striatum.—The afferent fibres of the corpus striatum arise in the thalamus and terminate in the caudate nucleus and the putamen of the lentiform nucleus. These parts are connected to the globus pallidus from which the efferent fibres arise; they pass to the red nucleus, the sub-thalamic nucleus, and the hypothalamus, and through them the corpus striatum has a part in the nervous mechanism of movement.

The sections which have been made through the thalamus show it to be composed chiefly of grey matter though its upper and lateral surfaces are coated with thin layers of white matter. The grey matter is incompletely divided into three parts, an anterior a medial, and a lateral nucleus, by a white medullary layer the lateral nucleus is by far the largest and includes the pulvinar The anterior nucleus receives the mammillo-thalamic tract (p. 326), and through it olfactory impressions from the rhinencephalon. The medial nucleus receives fibres from the anterior nucleus and from the sensory path which arises from the trigeminal nerve. It therefore correlates olfactory impressions with sensory impressions from the trigeminal area, and its efferent path leads to the sub-thalamic nucleus the caudate nucleus, and the putamen of the lentiform nucleus. The lateral nucleus receives most of the fibres of the medial lemniscus and from it fibres proceed to almost all parts of the cerebral cortex special bundles of them pass to the post-central gyrus and the frontal, temporal, and inferior parietal regions. The thalamus thus receives impulses from all the sensory receptors of the body and in it they are correlated with one another and the coarser more primitive (protopathic) of them reach recognition in consciousness this is probably most so of stimuli which are definitely noxious or beneficial, and their recognition is accompanied by increases in the affective state. These impulses find their motor outlet through the corpus striatum, and through it there is established a thalamo-striate

the fissure is interrupted by the decussation of the pyramids and it is then continued into the anterior fissure of the cord it ends above at the lower border of the pons in the foramen cæcum. On each side of the fissure is the swelling of the pyramid (Fig 129) Its upper end as it issues from the pons, is a little constricted and between it and the pons the abducent nerve appears on its lateral side and in series with the fila of the anterior roots of the spinal nerves, the fila of the hypoglossal nerve emerge in the groove between it and the olive (Fig 129) Each pyramid contains the continuation of the motor (cerebro-spinal pyramidal) tract, which when traced downwards divides into two parts. The greater number (about two-thirds) of the fibres of the tract cross to the opposite side of the spinal cord the crossing of the two sides forming what has been described above as the decussation of the pyramids the remaining fibres that is those of the lateral part of the pyramid do not cross but continue downwards in the anterior column of the cord. The pyramid of one side of the sectioned brain should be divided transversely about its middle and the two parts carefully raised. In this way the passage of the upper part into the medulla from the pons and the division of the lower part at the upper end of the spinal cord will be clearly demonstrated.

Lateral to the upper part of the pyramid in the interval which is bounded in front by the fila of the hypoglossal nerve and behind by the fila of the glosso-pharyngeal vagus and accessory nerves, there is the smooth oval prominence of the olive, and below the olive there is an area of the medulla which appears to be directly continuous with the lateral column of the spinal cord (Fig 129) It contains however only part of the fibres of the lateral column of the cord, and these when continued upwards dip beneath the olive and disappear from the surface. Between the olive and the pons there is a groove in which the two roots of the facial nerve are attached.

On the posterior surface of the medulla which is to be exposed as well as possible by raising the cerebellum the posterior fissure is seen in the lower part in the upper part of the medulla the central canal of the lower part which is continuous below with the central canal of the cord, expands into the cavity of the fourth ventricle The lips of the posterior fissure are, as it were, pushed aside and in the interval between them the roof of the ventricle appears (Fig 130) The medulla thus consists of two regions a lower closed region which contains a central canal and an upper open region which forms the floor and lateral boundaries of the lower part of the fourth ventricle On each side of the posterior fissure there are two longitudinal bands the tractus gracilis medially and the tractus cuneatus laterally (Fig 130) which are the direct upward prolongation of the posterior column of the spinal cord. These tracts are at first vertical but when followed upwards those of the two sides diverge laterally along the lateral walls of the lower part of the fourth ventricle and each of them ends there in a slight elongated swelling The swelling on the tractus gracilis is named the gracile tubercle or clava and that on the tractus cuneatus

the **vermis** and two lateral expanded parts named the **hemispheres**. The hemispheres are separated behind by a deep posterior notch and in front by a broad shallow anterior notch which lodges the pons and the upper part of the medulla. On the superior surface which slopes downwards and laterally on each side of the middle line the division into the three parts is not well marked the vermis forming only a slight median elevation but on the inferior surface the vermis lies at the bottom of a deep depression the **vallecula cerebelli**, which intervenes between the two hemispheres

The Subdivision of the Cerebellum.—Some of the fissures of the cerebellum are deeper and longer than others and have been used to subdivide it into lobes. One such fissure, the **great horizontal fissure**, which in a general way passes round the posterior and antero-lateral borders of the hemisphere and cuts deeply into it, has been used to divide it into upper and lower parts; its lips are separated in front by the brachium pontis in its passage into the cerebellum. It is, however of little morphological importance The chief morphological fissure is the **fissura prima**. It is a deep V-shaped fissure on the superior surface, the apex of which is on the back part of the superior vermis and the limbs run forwards and laterally on the hemispheres. It divides the cerebellum into two primary parts, an **antero-superior part** in front of the fissure and a **postero-inferior part** which lies behind the fissure the latter part includes the posterior part of the superior surface and the whole of the inferior surface. Both parts are further subdivided by secondary fissures into a number of lobes.

The cerebellum is connected to the other parts of the brain by three large bundles of projection fibres on each side these are the **cerebellar peduncles**. They are to be examined first on one half of the divided specimen and on it they should be traced into the white matter of the cerebellum by tearing away its substance at the great horizontal fissure. The **brachium pontis** (middle peduncle) is the largest. It is formed by the transverse fibres of the pons and enters the cerebellum at the anterior end of the great horizontal fissure and on the lateral side of the other peduncles (Fig. 130) The fibres it contains arise in the nuclei pontis of the opposite side and end in the cortex of the cerebellar hemisphere The **restiform body** is the inferior peduncle It carries into the cerebellum fibres which in the main are derived from the proprioceptive paths of the spinal cord, the nucleus gracilis and nucleus cuneatus the nucleus of the olive, and the vestibular nerve and vestibular nuclei. The superior peduncles are the **brachia conjunctiva**. They are to be examined on the undivided specimen by pulling the cerebellum gently backwards from the mid brain. They then appear as two large strands which emerge from the upper part of the anterior cerebellar notch and, lying at the sides of the dorsal surface of the pons converge as they proceed forwards they finally disappear under the inferior corpora quadrigemina (Fig. 130) They contain in the main the efferent fibres of the cerebellum which arise in the dentate nucleus in its substance they end chiefly in the red

the **cuneate tubercle** (Fig. 130) and it will be seen when the medulla is sectioned that both tubercles are due to underlying nuclei of grey matter the **nucleus gracilis** and **nucleus cuneatus**, in which the fibres of the tracts end. A third elevation, the **tubercle of Rolando**, narrow below but wider above lies between the *tractus cuneatus* and the fila of the accessory nerve; it is produced by a nucleus in which the descending (spinal) fibres of the sensory root of the trigeminal nerve end. The upper part of the posterior surface of the medulla is formed by the **restiform body** a thick rope like strand. The two bodies form the lateral boundaries of the lower part of the fourth ventricle; as they ascend they diverge from one another and finally turning backwards they enter the cerebellum of which they form the inferior peduncles. Near its termination each body is crossed posteriorly by several strands of fibres named the **auditory striae** (Fig. 130). The restiform body appears to be the upward continuation of the tractus gracilis and tractus cuneatus for it is not sharply marked off from them, but it contains no fibres which are directly prolonged into it from these tracts. Its constitution will be considered later but at present one group of fibres should be followed into it. These are the **external arcuate fibres** (Fig. 130). They vary greatly in number in different specimens, in some being scarcely visible and in others forming an almost continuous layer over the pyramid and the olive. They emerge on the surface at the anterior fissure and in the interval between the pyramid and the olive and pass backwards above the decussation of the pyramid to the restiform body.

The **cerebellum** lies behind the pons and the medulla, its median part being separated from them by the cavity of the fourth ventricle and its lateral part [illegible] ng th mselves [illegible] und the sides. It is characterised by th [illegible] losely set [illegible] urved parallel fissures which traverse its surface and extend into its substance. On the sectioned specimen the manner in which th[e] [illegible] bellum [illegible] th fissu es into a series of leaf like part th [illegible] will [illegible] n (Fig. 157) and it is seen to be formed [illegible] f whit [illegible] att[er] which [illegible] h of the folia [illegible] f grey [illegible] which [illegible] pread over th[e] surf[ace] [illegible] h g which [illegible] thu pr[o]duced has been [illegible] **arbor vitae**. The [illegible] unif rm in tructure in its [illegible] tructure occur in th [illegible] that the whole cerebell[um] [illegible] f [illegible] n [illegible] ng nd [illegible] fibres [illegible] part [illegible] and [illegible] of [illegible] nect it t th [illegible]

Th[e] [illegible] t [illegible] diamet [illegible] from [illegible] nw rd [illegible] f the skull project n [illegible] by the t nt rium [illegible] median part n [illegible]

(p. 291). From the under surface of the tela two choroid plexuses project into the ventricle, invaginating the ependymal roof. At the lower part of the ventricle they lie parallel with one another close to the middle line (Fig 133), but above they become horizontal and are carried into the lateral recesses.

The peduncles of the cerebellum are to be cut through and it is to be removed. The floor of the fourth ventricle which is formed by the posterior surface of the pons above and the upper part of the medulla below and its lateral boundaries can now be examined (Fig 130)

The lateral boundaries of the fourth ventricle are formed on each side from below upwards, by the gracile tubercle (clava), the cuneate tubercle, and

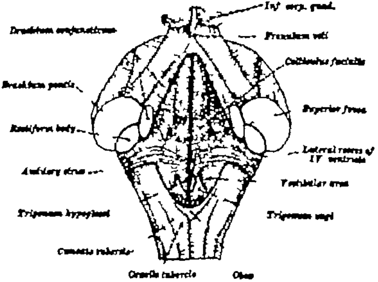


FIG. 130.

Diagram of the floor and lateral boundaries of the fourth ventricle. The cerebellar peduncles have been divided and the superior and inferior medullary vela removed.

the restiform body below and by the brachium pontis and the brachium conjunctivum above (Fig 130). Along the margins of the lower boundaries there will be seen the remains of the torn ependymal roof and two narrow white bands, named the taeniae of the fourth ventricle; these bands meet over the lower angle of the ventricle in a thin triangular fold of grey matter named the obex (Fig 130).

The floor of the fourth ventricle is rhomboidal in shape. It is divided into lateral halves by a median sulcus which is deeper below than it is above, and each half is again divided into upper and lower parts by strands of fibres, the auditory striae, which pass from the lateral angle across the restiform body and the floor to the median sulcus (Fig 130) The upper parts of the floor may be described as the dorsal surface of the pons and the lower parts as the dorsal surface of the upper part of the medulla. In the upper or pontine part of the floor there is on each side of the median sulcus the eminentia

nucleus of the mid brain. The brachia are connected together by the **superior medullary velum**, a thin triangular lamina of white matter which stretches between their medial edges and forms the roof of the upper part of the fourth ventricle (Fig 131) its white substance is continuous below with the white substance of the vermis of the cerebellum. On the surface of the velum there is a small tongue-shaped process of the grey matter of the cerebellum named the **lingula**, and issuing from it close to the inferior corpora quadrigemina at the sides of the frenulum veli (p. 326) are the **trochlear nerves**.

Horizontal sections are now to be made through the cerebellum on that half of the divided brain which has not been torn, until there is exposed in the white matter of each hemisphere a thin waved lamina of grey matter this is the **dentate nucleus**. It is placed a little to the medial side of the centre of the white matter of the hemisphere and rather nearer the upper than the lower surface and is folded on itself so as to have a horseshoe shape, the opening of which is directed forwards and medially The greater number of fibres which form the brachium conjunctivum arise from its cells and issue from the opening, while ending round it are fibres from the cerebellar cortex.

The undivided specimen is now to be laid with the pons and medulla downwards. The cerebellum is to be divided in the middle line of the vermis from the posterior cerebellar notch towards the **fourth ventricle**, so that this cavity is opened through its roof. The two halves of the cerebellum are to be pulled far enough apart to allow the dissector to look into the cavity and examine its general form. It is rhomboidal in shape (Fig 130). Its pointed extremities are at its anterior and posterior ends where it is continued into the cerebral aqueduct of the mid-brain above and the central canal of the lower part of the medulla below while on each side, from its lateral angles, there is a narrow **lateral recess** of the cavity prolonged over the upper surface of the restiform body (Fig 130) The roof of the cavity as has already been seen on the sectioned brain (Fig 107) is formed by the superior medullary velum above, the white matter of the vermis of the cerebellum in the middle and the **inferior medullary velum** below The first two parts are easily recognised, but there may be difficulty in demonstrating the last part.

The **inferior medullary velum** is a broad thin translucent layer of white matter divided into two lateral parts; it is continuous bove with the white matter of the cerebellum. It forms only a small part of the ventricular roof for it soon ends in a ragged concave margin, and below the margin the roof of the lower part of the ventricle is devoid of nervous matter; it is formed by the thin ependymal lining membrane. This part of the roof, therefore, resembles the roof of the third ventricle and like it it is covered and strengthened by a layer of pia mater which is named the **tela chorioidea** of the fourth ventricle. The ependymal roof and the tela are perforated over the lower pointed angle of the ventricle and at the pices of the lateral recesses, and through the three openings the cavity of the ventricle communicates with the sub-arachnoid space and cerebro-spinal fluid can pass from the ventricle into the space

motor (cerebro-spinal, pyramidal) tract, proceeding downwards from the mid brain to form the pyramids of the medulla. Scattered among the fibres there are collections of grey matter forming the nuclei pontis, round which the fibres of the cerebro-pontine tracts end and from which the transverse fibres of the pons arise. The posterior part of the pons is named the tegmentum. It is continuous above with the tegmental parts of the mid brain (p. 331). On its dorsal surface there is a layer of grey matter which is spread over the floor of the fourth ventricle, and at the sides the brachia conjunctiva, semilunar in shape, are seen in section; between them the superior medullary velum roofs over the ventricle. A median raphe divides this part of the pons into two lateral parts, in each of which three bundles of longitudinal fibres should be sought (Fig 131). (1) The medial longitudinal bundle lies close to the median plane immediately below the grey matter of the floor of the ventricle. (2) The medial lemniscus is a flat bundle placed between the anterior and

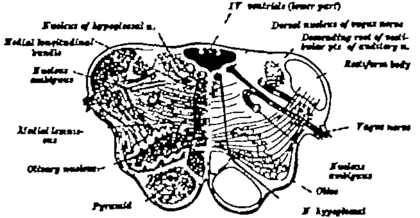


Fig 132.

A transverse section f the medulla through th olives. The thickness of the roof of the ventricle is exaggerated; projecting from it are the choroid plexuses.

posterior parts of the pons. (3) The lateral lemniscus, seen only in sections through the upper parts of the pons, lies on the lateral side of th lower part of the brachium conjunctivum.

A transverse section through the medulla oblongata at the level of the olives shows that it is divided int lateral halves by median raphe (Fig 132) In each half there can be distinguished (1) The olivary nucleus, which lies subjacent to the olivary eminence and appears as a thick waved line of grey matter folded on itself like a horseshoe, the opening being directed towards the median raphe. (2) The motor tract, which forms the substance of the pyramid, is continued from the scattered pyramidal bundles of the pons and in sections at lower level the decussation of the majority of its fibres, at the decussation of the pyramids, should be seen. (3) The medial longitudinal bundle lies close t the median raphe in the posterior part of the medulla. (4) The medial lemniscus lies close t the median raphe immediately above the pyramid. It commences in part in the nucleus gracilis and nucleus cuneatus of the opposite side and these masses of grey matter should be sought in sections through the gracile and cuneat tubercles.

medialis, the lower end of which, a nodular prominence, is named the colliculus facialis. It is bounded laterally by a sulcus (sulcus limitans) which expands below into a small triangular depression, the superior fovea. Along the lateral border of the upper part of the sulcus there is a narrow area named the locus cæruleus from its faint bluish colour; the colour is due to an underlying collection of pigmented cells, the substantia ferruginea. In the lower or medullary area of the floor there is, on each side of the middle line, a triangular depression, the inferior fovea, the apex of which is directed towards the auditory striæ. The triangular area between the two limbs of the fovea is named the trigonum vagi, since the dorsal nucleus of the vagus lies deep to it. Medial to the trigonum vagi, between it and the median sulcus, is the trigonum hypoglossi, the medial part of which marks the position of the nucleus of the hypoglossal nerve, while lateral to the trigonum vagi and extending upwards

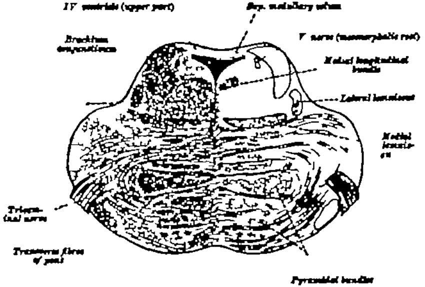


FIG. 131.

A transverse section through the upper part of the pons.

int the pontine area is the vestibular area, under which lies the nuclei of the vestibular part of the auditory nerve. The medullary area of the floor of the ventricle thus divided, is sometimes named the calamus scriptorius.

A series of transverse sections should now be made through the pons and medulla, for though little of the details of their structure can be learnt from unprepared specimens yet their general outline and some of the important parts can be recognised. They should be compared with the sections made through the mid brain.

A transverse section of the pons shows that it consists of two parts, an anterior and a posterior part (Fig. 131). The anterior is the larger part. It consists of a number of bundles of transverse fibres intermingled with which there are bundles of longitudinal fibres; the latter are the fibres of the

motor (cerebro-spinal, pyramidal) tract, proceeding downwards from the mid brain to form the pyramids of the medulla. Scattered among the fibres there are collections of grey matter forming the nuclei pontis, round which the fibres of the cerebro-pontine tracts end and from which the transverse fibres of the pons arise. The posterior part of the pons is named the tegmentum. It is continuous above with the tegmental parts of the mid brain (p. 331). On its dorsal surface there is a layer of grey matter which is spread over the floor of the fourth ventricle and at the sides the brachia conjunctiva, semilunar in shape, are seen in section; between them the superior medullary velum roofs over the ventricle. A median raphe divides this part of the pons into two lateral parts, in each of which three bundles of longitudinal fibres should be sought (Fig 131). (1) The medial longitudinal bundle lies close to the median plane immediately below the grey matter of the floor of the ventricle. (2) The medial lemniscus is a flat bundle placed between the anterior and

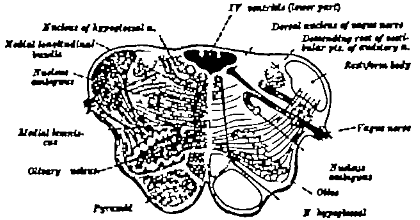


FIG. 132.

A transverse section of the medulla through the olives. The thickness of the roof f the ventricle is exaggerated; projecting from it are the choroid plexuses.

posterior parts of the pons. (3) The lateral lemniscus, seen only in sections through the upper parts of the pons, lies on the lateral side of the lower part of the brachium conjunctivum.

A transverse section through the medulla oblongata at th level of the olives shows that it is divided into lateral halves by a median raphe (Fig 132). In each half there can be distinguished: (1) The olivary nucleus, which lies subjacent to the olivary eminence and appears as a thick waved line of grey matter folded on itself like a horseshoe, the opening being directed towards the median raphe. (2) The motor tract, which forms the substance of the pyramid, is continued from the scattered pyramidal bundles of the pons and in sections at a lower level the decussation of the majority of its fibres, at the decussation of the pyramids, should be seen. (3) The medial longitudinal bundle lies lose t the median raphe in the posterior part of the medulla. (4) The medial lemniscus lies close to the median raphe immediately above the pyramid It commences in part in the nucleus gracilis and nucleus cuneatus of the opposite side, and these masses of grey matter should be sought in sections through the gracile and cuneate tubercles.

The Spinal Cord

The general anatomy of the spinal cord has already been described (p. 170) and the arrangement of the spinal meninges has been examined (p. 168) It remains now to study the blood supply of the cord and its internal structure as far as this can be done on the specimen which has been retained.

The arteries of the spinal cord are arranged as three longitudinal trunks on its surface. One of them, the anterior spinal artery lies in the middle line in front in the pia mater under cover of the linea splendens. It is formed above by the union of the two anterior spinal branches of the vertebral arteries which arise within the skull, and the single trunk they form descends on the front of the cord (Fig. 110). The other longitudinal trunks, the posterior spinal arteries, lie in front of the posterior nerve roots on each side of the cord, and branches from them form a free anastomosis round the roots; a longitudinal trunk is often found behind the roots. They commence above within the skull as the posterior spinal branches of the vertebral arteries (p. 296). As the three spinal arteries descend on the cord they are reinforced by a succession of small lateral branches which enter the vertebral canal through the inter vertebral foramina (p. 167). These branches are derived from the vertebral, ascending cervical, intercostal, and lumbar arteries, and by their means the longitudinal stems are continued to the lower end of the cord.

The branches of the main vessels ramify in the inner layer of the pia mater and from there enter the substance of the cord.

The veins of the spinal cord are small and form a tortuous plexus in the pia mater on its surface. In the plexus there are two median longitudinal trunks, one in front and one behind, and four lateral trunks related to the anterior and posterior nerve roots. The spinal plexus communicates with the internal vertebral plexus by small twigs which run laterally on the nerve roots.

If the spinal cord is at all well preserved a good deal can be learned of its internal structure if transverse sections of it are made at different levels and these are examined with a hand-lens. It is an interesting experiment, and facilitates their study to immerse some of the sections in ordinary ink for about three minutes and then well wash them in water

The sections from the thoracic region of the cord are almost circular while those from the cervical and lumbar enlargements are not only larger but also more oval. On each section (Fig 153) there can be seen the anterior fissure and the posterior septum, both lying in the median plane the former contains a fold of pia mater and the anterior spinal artery They partially divide the cord into right and left halves, but the two sides are connected across the middle line by white and grey commissures which intervene between the fissure and the septum. It will also be noted that along the line of entrance of the posterior nerve roots there is a definite groove the postero-lateral sulcus there is no similar groove opposite the attachment of the anterior roots since they emerge from the cord over the whole width of the underlying anterior horn of grey matter

An inspection of the surface of the transverse sections shows that the spinal cord is composed of a central core of **grey matter** and a peripheral coating of **white matter** which surrounds the grey matter on all sides (Fig. 133)

The **grey matter** is in the form of the letter H, a comma-shaped mass concave laterally lying in each half of the cord and being connected to that of the opposite side by a narrow transverse band named the **grey commissure**. In the grey commissure just visible to the naked eye, there is the **central canal of the cord**. The canal runs the entire length of the cord and is continued into the upper part of the filum terminale above it is continued into the central canal of the lower part of the medulla. Each lateral crescentic mass of grey matter consists of an **anterior** and a **posterior horn**. The anterior horn

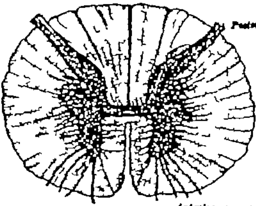


FIG. 133.

Diagram of a transverse section of the spinal cord. The student should name the anterior fissure and the posterior septum, the diff rent parts of the grey matter, th central canal of the cord, and the columns of the white matter

is short, thick and rounded and is separated from the surface of the cord by an intervening layer of white matter The posterior horn, on the other hand, is narrow and pointed and almost reaches the surface of the cord opposite the attachments of the posterior nerve roots. It consists of a **base**, which is continuous with the base of the anterior horn, a constricted **neck**, and an oval **head**, the apex of which is capped by a Λ-shaped mass of translucent tissue named the **substantia gelatinosa**. In the thoracic and upper lumbar regions of the cord there is also a **lateral horn** of grey matter it is a pointed lateral projection opposite the grey commissure.

The grey matter is not present in equal amount in all parts of the cord, being much increased opposite the attachments of the nerves which form the limb plexuses, that is, in the cervical and lumbar enlargements. The shape of the grey matter also differs in different regions of the cord and a section

taken from each region could be readily recognised. The anterior horn contains the motor (anterior cornual) cells from which arise the fibres of the anterior roots of the spinal nerves, and the posterior horn contains the cells round which most of the fibres of the posterior roots end; the lateral horn contains the motor cells which give origin to the pre-ganglionic sympathetic fibres.

The white matter covers the grey matter and in each half of the cord is marked off by it into three columns or funiculi (Fig. 133). The **posterior column** is wedge-shaped on transverse section and lies between the posterior horn of grey matter and the posterior septum. In the cervical region indications may be seen of a septum dividing it into two parts, the tractus gracilis medially and the tractus cuneatus laterally. The **lateral column** lies opposite the grey matter being bounded behind by the posterior horn of grey matter and in front by the most lateral of the anterior nerve roots. The **anterior column** comprises the white matter between the anterior fissure and the most lateral of the anterior nerve roots. The two anterior columns are connected together across the middle line by the white commissure which lies between the grey commissure and the bottom of the anterior fissure.

The white matter chiefly consists of medullated nerve fibres, the vast majority of which have a longitudinal course. They are divisible into two main groups, namely: (1) **Association or inter-segmental fibres** which link together different levels of the cord, and (2) **projection (itinerant) fibres** which connect the cord to the brain and convey impulses to and from it; some projection fibres cross from one side of the cord to the other in the anterior white commissure. The fibres are grouped into bundles or tracts according to the connexions they establish and, though there is no evidence of it in the natural state, the whole of the white matter has now been analysed into its constituent tracts. The association tracts, for example, are closely applied to the surface of the grey matter; the tractus gracilis and tractus cuneatus of the posterior column consist of fibres of the posterior nerve roots ascending to the nucleus gracilis and nucleus cuneatus of the medulla; the crossed fibres of the motor (pyramidal, cerebro-spinal) track lie in the back part of the lateral column and the uncrossed fibres in anterior column close to the anterior fissure; and the superficial parts of the lateral and anterior columns comprise a series of ascending (sensory) tracts which commence in the cells of the posterior horn. The details of the tracts are to be studied in the text-book.

INDEX

taken from each region could be readily recognised. The anterior horn contains the motor (anterior cornual) cells from which arise the fibres of the anterior roots of the spinal nerves, and the posterior horn contains the cells round which most of the fibres of the posterior roots end; the lateral horn contains the motor cells which give origin to the pre-ganglionic sympathetic fibres.

The white matter covers the grey matter and in each half of the cord is marked off by it into three columns or funiculi (Fig. 135). The posterior column is wedge-shaped on transverse section and lies between the posterior horn of grey matter and the posterior septum. In the cervical region indications may be seen of a septum dividing it into two parts, the tractus gracilis medially and the tractus cuneatus laterally. The lateral column lies opposite the grey matter being bounded behind by the posterior horn of grey matter and in front by the most lateral of the anterior nerve roots. The anterior column comprises the white matter between the anterior fissure and the most lateral of the anterior nerve roots. The two anterior columns are connected together across the middle line by the white commissure which lies between the grey commissure and the bottom of the anterior fissure.

The white matter chiefly consists of medullated nerve fibres, the vast majority of which have a longitudinal course. They are divisible into two main groups, namely (1) Association or inter-segmental fibres which link together different levels of the cord, and (2) projection (itinerant) fibres which connect the cord to the brain and convey impulses to and from it; some projection fibres cross from one side of the cord to the other in the anterior white commissure. The fibres are grouped into bundles or tracts according to the connexions they establish and, though there is no evidence of it in the natural state, the whole of the white matter has now been analysed into its constituent tracts. The association tracts, for example, are closely applied to the surface of the grey matter; the tractus gracilis and tractus cuneatus of the posterior column consist of fibres of the posterior nerve roots ascending to the nucleus gracilis and nucleus cuneatus of the medulla; the crossed fibres of the motor (pyramidal, cerebro-spinal) track lie in the back part of the lateral column and the uncrossed fibres in anterior column close to the anterior fissure; and the superficial parts of the lateral and anterior columns comprise a series of ascending (sensory) tracts which commence in the cells of the posterior horn. The details of the tracts are to be studied in the text-book.